



IITH pays tribute to a great teacher
'Dr. Sarvepalli Radhakrishnan'
and celebrates Teacherhood

किरणीIITH

the crowning glory —

A quarterly e-newsletter of IITH | Issue - 3 | June 2020

#Arena of AI @IITH



भारतीय प्रौद्योगिकी संस्थान हैदराबाद
Indian Institute of Technology Hyderabad

Cover Image:

Mountains using AI: This artwork is made using Artificial Intelligence by Joseph Jayadev Tsukka under the guidance of Prof. Deepak John Mathew, Department of Design.

This above computer-generated art uses techniques from traditional procedural programming and deep learning. There are two deep learning models used in this artwork, one model generates photorealistic output from given semantics and the other model uses style transfer - a process of adding style to an image while preserving the content. In the above image, the semantics of snow and mountains are mapped as triangles which are repeated randomly on the bottom half while the top half is mapped with the semantic - sky. After the semantics are laid out, the photorealistic output is generated which is then fed into the style transfer model trained on the style of the artist, 'Nicholas Roerich'.

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We are back again with क्रिएटिवIITH - The Crowning Glory. This issue will take you to the tours of various researches, happenings & recognitions related to the latest trending research area - AI / ML and hence named as “क्रिएटिवIITH - The Crowning Glory - Issue – 3, June, 2020 #Arena of AI @IITH”.

This special edition on AI initiatives at IITH was only possible because of the visionary thought process of our Director, Prof. B. S. Murty. Right from the cover page to Alumni column, we have ensured you get a flavour of AI in this issue. This issue contains rich research content for AI lovers.

This issue could embody the Arena of AI at IITH because of humble and duteous support extended by Dr. Vineeth N Balasubramanian (HoD - AI).

We have released this issue on 5th September 2020, as a tribute to a great teacher ‘Dr. Sarvepalli Radhakrishnan’ and to celebrate Teacherhood.

We hope you appreciate this initiative to bring out IITH's magazine specific to a theme.

We will meet you with the next issue soon.

Happy Reading...

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Director's Desk

Dear friends,

I hope you are all safe and doing great!

As we all know, we are going through tough times both personally and professionally. This situation reminds me of the book that I read during my undergraduate days “Tough times never last but tough people Do” by Robert H. Schuller. It is such conditions that many a times bring the best out of us.

IIT Hyderabad has also taken this situation as an opportunity to explore new things. The Last issue we brought has depicted it. Around 50 Faculty Projects and about 10 Students projects have focused on the ways to fight against the COVID-19 and we dedicated our last KIRIITH issue the research activity of IITH in this field.

The present issue brings out a unique feature of IITH, the academic and research activity in the area of AI and ML. IITH has become a Center wherein wonderful innovations are being churn out in this fascinating field and I am sure you will enjoy going through this KIRIITH issue that is dedicated to AI.

With the increase in the number of COVID-19 infected persons, it became the utmost priority to develop faster and effective test kit. Our faculty Prof. Shiv Govind Singh has developed a rapid test kit to diagnosis COVID-19 in an economic way and he is in the process to complete the required certification so that it can be mass-produced for wider reach. The Jeevan Lite ventilator from Aerobiosys, an incubator from Centre for Health Care Entrepreneurship of IITH is another example of relentless fight of IITH with Covid-19. The latest in this series of developments is the Usafe Health Care reusable respirator mask, is a high quality affordable mask that came out of IITH with the support of Dr. Surya Kumar and Prof. Renu John.

Amid this COVID-19 situation, we have ensured academic excellence too. IITH has announced a number of new industry-oriented M. Tech program in collaboration with the industry experts, effective from September 2020. These include Additive Manufacturing, Energy Science and Technology, E-Waste Resource Engineering and Management, Integrated Sensor System, Network and Information Security, Polymers and Biosystems Engineering, Smart Mobility.

Taking our relations with Japan a step ahead, we have signed an MoU with Japanese financial firm New Frontier Capital Management (NFCM) to create a global network of Venture Ecosystem and also to establish ‘Joint Innovation Centers’ in Tokyo, Japan, and Telangana State.

To strengthen our alliances with the Industry, IITH has also partnered with Confederation of Indian Industry (CII) and launched CII-IITH-IWN power talks. Every Saturday we have a talk from either an Industry expert or an IITH’s academician. Total of 4 Power-talks has been successfully organized in the last quarter.

We have also taken a decision to call back the PhD scholars in limited numbers with all necessary precautions and protocols, so that they can carry on with their experiments.

Under these conditions, protecting yourself is serving the society. Wearing a mask, maintaining social distancing and personal hygiene is the new normal. Do practice them for the well-being of self, family and society. Looking forward to seeing you all soon...

Prof. B. S. Murty



IITH progress so far from Dean (Planning)

Prof. Sireesh Saride

IIT Hyderabad Campus is sprawling over 600 acres of green fields surrounded by villages and towns, yet close to Hyderabad city. This setting makes a living on Campus very within. The vast Campus is divided into well-thought-of zoning systems, including Academic, Residential, Recreational, and Central amenities. The Campus master plan was developed based on the concepts of conservation and sustainability, energy-efficient and green yet urban framework with a 60% greenery.

The academic zone is a crucible of interdisciplinary research to promote a sense of excellence and inspire inventions and innovations. IIT Hyderabad offers independent living spaces with natural ventilation and diffused lighting and a radiant cooling system for students to explore themselves, still provide a lot of interaction spaces in the hostel living and academic zones.

Currently, the Campus accommodates about 2500 students and is shifting gears to accommodate about 5000 students by the end of 2023. IIT Hyderabad Campus has started Phase-II construction activities with the aid from the Japan International Cooperation Agency (JICA), which is expected to complete in three years. It is adding nine academic blocks from the existing three academic blocks. A state-of-the-art Knowledge Centre (library), Research Centre Complex, Lecture Hall Complex with an 800-seater capacity hall, Technology Incubation Park, Sports, and

Cultural Complex with international standards are some of the highlights of the Phase-II development. Though the construction activities are hampered by the COVID-19 pandemic, with constant support from all the stakeholders, IIT Hyderabad has almost brought the construction activities on track to complete the project in time.

IIT Hyderabad is thriving to provide the best possible facilities and infrastructure, and I am sure the Campus is one of the most livable, vibrant, and dynamic campuses with international standards in India.

A hearty welcome to IIT Hyderabad!



Synopsis - Students' Affair from Dean (Students) Prof. P. Rajalakshmi

It is my pleasure to share the student activities at IITH in this issue of the Institute's Newsletter क्रीIITH.

Hope all the students are safe and doing good.

Students at IITH excel both in academics and extracurricular activities. Amid the lock-down situation, several online events are being conducted for students which include Quarantine Cooking Challenge, Poster Making Competition, Slogan Writing Competition, Drawing Competition, Mandala Art Challenge, Online Quiz Competition and Poetry Competition.

IITH has managed to do the best for the students both physically and mental well-being of the students, during this pandemic situation. Regular online yoga sessions are being conducted for the students, to help them maintain good health and be fit. "Ek Bharat Shrestha Bharat" (EBSB) Club of IITH observed 6th International Yoga Day with full enthusiasm in online mode which was a huge success with participation from many students, faculty and staffs. Sunshine – counselling cell at IITH, has conducted individual, group and interactive sessions for the students through various online modes. Articles on motivation, power of self-confidence, managing difficult emotions, etc.. were periodically shared with the students

Extra Mural Lectures at IITH intend to bring eminent personalities from eclectic domains on one platform to talk

about various subjects like art, social work, economics, psychology, sports, science, etc and inspire IITH fraternity with insights. We had speakers from a wide spectrum of areas like Success Secrets for Students by Dr. B. V. Pattabhiram, Gandhian Principles by R. K. Paliwal (Director-General, IT Department), Interaction session with Dr. Y. V. Reddy, Ex-Governor RBI, and Juggling by Mr. Satwinder Singh Setia.

The annual techno-cultural fest of IIT Hyderabad, ELAN & NVision offers a host of exciting competitions to test one's skills, informal events and pro-shows to the event unforgettable. IITH's BOG Chairman, Dr. B. V. R. Mohan Reddy also inaugurated the first issue of "क्रीIITH - The Crowning Glory" - Quarterly e-magazine of IITH" during this edition of Elan & nVision on 16th, February, 2020.

Milan - The General Championship 2020 was launched this year at IITH which was 10 days long inter-hostel celebrations including Sports, Cultural events and SciTech activities. The objective was to promote cohesiveness among the students. Around 200 students from IITH actively participated in Inter IIT Tech Meet held in IIT Roorkee, Inter IIT Sports Meet held in IIT Kharagpur & IIT Bhubaneswar, Inter IIT Cultural Meet held in IIT Bombay, bringing laurels to IITH by winning prizes in various competitions held during the meet.

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The NSS team at IITH is actively involved in various community development programs like UDAAN - Study centre where the students teach underprivileged children free of cost; Vidhaydaan - Remedials to clarify concepts/doubts of school kids through traditional, fun way and short videos; Swacchatha he Seva and Plastic waste-free campaigns; Orphanage visit; National Education Day; Clean India Drive; and Fit India Movement. The first Saturday of every month is identified as 'Green Day of Month', where students participate in the mass plantation in the campus along with faculty and staff.

To promote creativity and innovation among students, IITH has started the BUILD program - Bold and Unique Ideas Leading to Development. Under this program, student projects with a novel idea is supported for 6 months up to a funding of 1 Lakhs for prototype development. A total of 16 projects was selected this year, out of which around 8 projects were related to COVID.

Hostels at IITH have top-class facilities like rooms with Radiant Cooling Technology, Recreation Center, High-speed Internet Connectivity, Mess, Gym, Indoor Games, TV Room, Dance Room, Banking Services, 24X7 Medical Service, Canteen facility and Security. Due to pandemic, considering the safety of students, IITH advised them to return home in mid of March 2020. Recently, IITH has started bringing students back to campus in stages, starting from 10 August 2020, adopting all necessary safety measures.

Hoping to see all students back to campus and resuming all activities in full swing on campus.



Hear from HoD – AI

Dr. Vineeth N Balasubramanian

The Department of Artificial Intelligence (AI) at IIT-Hyderabad was established in 2019 to offer academic programs and mould students with a **holistic understanding of the theory and practice of Artificial Intelligence**, as well as to create a complete ecosystem for both academic practice and research in AI. The mission of the department is to enable and facilitate students to become leaders in the AI industry and academia nationally and internationally; as well as to meet the pressing demands of the country in the various sub-areas and applications of AI. While AI has historically remained a topic studied inside departments such as Computer Science or Electrical Engineering, the creation of this new department at IIT-Hyderabad (only such in the IIT system at this time) allows us to **bring together AI knowledge from multiple perspectives**: Computer Science and Engineering, Electrical Engineering (topics such as signal processing and control theory), Mechanical Engineering (topics such as robotics), Mathematics, Biomedical Engineering (topics such as computational neuroscience), Design (topics such as Human-Computer Interaction), as well as Liberal Arts (topics at the intersection of AI, Ethics and Human Impact) into unified program offerings.

The AI department at IIT-H launched the **BTech in AI program in 2019, the first such initiative in India, and the third in the world (to our knowledge) after MIT and CMU**. The undergraduate program brings together the aforementioned perspectives, as well as now includes opportunities for meritorious students to embark on 6-month internships

during the program, which can count for their credit requirements after a suitable evaluation of the work carried out. Our BTech program has resulted in many other similar programs across the country, and the department has helped many other institutions design their curricula for similar undergraduate programs. The presence of an AI department also allows students from other departments at IIT-H to pursue a **minor in AI**, along with their major discipline. This opportunity allows students to learn to connect AI to their own disciplines, a trend that is fast spreading in the industry in applying AI to problems in various domains ranging from structural engineering to drug discovery.

In addition to the undergraduate program in AI, the department also offers **post-graduate degrees include MTech and PhD in AI**. While a specialization in AI is offered in several institutions in India currently at an MTech level, a PhD program in AI is less available. Our PhD in AI program was created with two reasons in mind: (i) to open up opportunities in PhD-level research in AI to a wider group of candidates who may have basic academic training in different areas but have strong mathematical foundations (e.g. a student from a statistics or an applied physics background in their previous education); and (ii) to engage with and provide opportunities to professionals in the Indian industry, considering a recent increasing interest in AI research and practice. We hope that our efforts in this regard will bear fruits in the years to come.

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In addition to the above programs, the AI department, in collaboration with CSE and EE departments, also offers a unique **Professional Program in AI and Emerging Technologies, a fully residential summer program** offered in collaboration with TalentSprint to anyone in the country. This program seeks to overcome the limitation that the education imparted by the IIT system in the country only reaches a select set of individuals. By opening up the 5-week residential program to any interested student, we hope that the students can learn from the department's expertise in AI, as well as experience the culture in an IIT campus, and take home lessons that can be further shared with their peers and colleagues.

The AI department at IIT-H currently consists of **~25 faculty working in various areas of AI** including machine learning, computer vision, speech understanding, natural language processing, social media analysis, robotics, signal processing, high-dimensional data analysis, distributed AI, compilers for AI, and embedded AI. It also includes faculty at the intersection of AI and other disciplines such as AI and IoT, AI and blockchains, AI and wireless networks, as well as AI and design. From an application standpoint, faculty associated with the AI department have been involved in projects conducting research and development of AI solutions for healthcare, smart transport, security and surveillance, agriculture, disaster management, fraud analytics, e-commerce, astronomy and aerospace applications. Faculty in the AI department have close collaborations with various industry, academic and government organizations on AI research including DRDO, CAIR, University of Tokyo, RIKEN AIP, Microsoft Research, IBM Research, NVIDIA, Accenture, Honeywell, Adobe, L V Prasad Eye Institute, and many others.

The department is at the cusp of the **establishment of a state-of-the-art AI Centre**, which is funded by the support of Honeywell and the Japan International Cooperation Agency. The computing facilities at the AI Centre includes NVIDIA DGX-1s, DGX-2s - widely considered AI supercomputers - as well as other GPU-based servers for cutting-edge research. The department also recently entered into a **close collaboration with NVIDIA to establish an NVIDIA Artificial Intelligence Technology Centre (NVAITC), India's first such initiative**, that allows researchers at IIT-H to work closely with engineers at NVIDIA to collaboratively solve problems of social impact. An article on the department website, <https://ai.iith.ac.in/news/July-2020-NVIDIA-establishes-Indias-first-NV-AI-Centre-at-IIT-Hyderabad.html>, provides more details on this new partnership. Faculty in the AI department also actively contribute to mentoring deep tech startups in AI at the newly founded AISEA (AFI i-TIC Foundation Social Entrepreneurship Accelerator), set up jointly by AFI and i-TIC Foundation of IIT Hyderabad and sponsored by the Department of Science and Technology, Government of India, to promote social entrepreneurship by leveraging contemporary technologies. The department is actively engaged with the Government of Telangana, in its declaration of 2020 as the Year of AI, and recently embarked on a close **collaboration with NASSCOM on the Telangana AI Mission** on AI for Agriculture.

We believe that this is a humble beginning, and that the department can scale greater heights in the years to come, in charting new paths in AI pedagogy and research. We invite you to visit our website, <https://ai.iith.ac.in/>, to know more about us and our efforts in this regard, and look forward to forging more meaningful and impactful collaborations in the years to come.



IIT Hyderabad had a fabulous journey so far in the National Institutional Ranking Framework (NIRF). In the first edition of NIRF, IITH secured 7th rank in the engineering category. In the subsequent editions of NIRF, we maintained 10th, 9th, 8th and 8th rank respectively in the engineering category. The overall ranking was introduced by NIRF in the year 2017 and IITH was ranked 26th. In the subsequent two years, we improved our overall rank to 22, and in 2020, we further improved our overall rank to 17. In fact, within NIRF, IITH is the only second-generation IIT that consistently made into the top 10 engineering institutes in the country.

IITH's score on some parameters such as faculty-student ratio, faculty qualification, financial resource utilization, patents, and footprint of projects, are comparable or higher than some of the older generation IITs. The financial support to IITH by JICA and the collaboration with Japanese Universities definitely played a critical role in the research output of IITH. A large number of state-of-the-art research instruments under the JICA support are being procured and installed at IITH. These facilities will help the scholars at IITH to perform research that cuts across the boundaries of conventional engineering and science departments. With further expansion in the campus

infrastructure and an increase in the number of students and faculty members, IITH is certain to climb up the ladder of science and engineering education in the country.

IITH enjoys a public perception score that is comparable to that of some of the older IITs. The second generation of IITs had the enormous advantage that they sailed on the brand IIT that was created by the old 5 IITs. However, today IITH is a brand of its own. This achievement is merely due to the sheer hard work of the students, staff, faculty members and the vision of the torch bearers of this institute and more importantly our alumni. With new and interdisciplinary academic programs that are need of the hour, IITH is destined to attract a pool of highly talented students and faculty members. Recently, IITH started a Centre for rural technology development. This new Centre and the new academic programs are going to open the doors to more and more interdisciplinary research that will have a high impact and relevance in solving the technological problem that the country is facing today. We are in the process of building an institute that will set an example of academic and research excellence.

IITH has been also ranked among Top 10 institutes in the country by QS World University Ranking.

Executive Diary

All about AI@IITH &
what new in the field of AI



Artificial Intelligence is perhaps the hottest phrase going around the world – not just among high technology persons but among all. Today, in India, almost all NBA accredited colleges have a program in AI or AI and DS or CS and AI (some permutation or combination of AI and DS). How did this come about? Here IITH faculty can take a lot of pride – because it all started with IITH taking the lead.

It was some time in late 2018 when some email exchanges started about what role should IITH play in AI. It was motivated by strong academic program activity in AI at Carnegie Mellon University and then at MIT. In fact, the proclamation by MIT that it will invest a billion dollars to create a new college focusing on AI, Machine Learning and Data Science (<https://www.technologyreview.com/2018/10/15/139781/mit-has-just-announced-a-1-billion-plan-to-create-a-new-college-for-ai/>), created a lot of buzz at IITH. At that time, the then Director started having informal consultation with faculty members, in CSE and EE, who were doing some work in AI or AI-related research. The overall opinion on starting a program was positive though several concerns were well articulated. IITH had the advantage of starting an online Executive M.Tech. in Data Science (2015) for working professionals, and M.Tech. in Machine Learning (2017). Because of this, three big advantages were on IITH's side: (i) Confidence in starting new innovative programs in cutting edge areas, (ii) faculty strength in DS and ML (though not adequate but enough to make an impact), and (iii) most importantly, a spirit of leadership and courage.

Many meetings ensued since the early informal discussions with faculty on starting a B.Tech. in AI. Each meeting was productive, and each meeting had heated discussions. Passions were high on both sides. It was this passion among the faculty, leadership of the faculty, the courage of the faculty, and of course, the confidence among the faculty that they will deliver world-class education in AI, that eventually led the decision to start a B.Tech. in AI at IITH in August 2019. This was the first of its kind, possibly in the world.

Next in line was the debate on who will run this program; will it be under the CSE Dept., will it be under the EE Dept., will it be jointly run by CSE and EE. Here, IITH had set an innovative precedence. Some years ago, IITH started the first of its kind in India, a B.Tech. in the Engineering Science program.

This program was run by a virtual Department of Engineering Science. What does one mean by a virtual department – a department wherein we do not hire any faculty and the department consists of faculty members from all other departments. There was no imposition, it was left to the faculty whether he/she wanted to be associated with Dept. of Engineering Science. Well, the response was overwhelming both from faculty and students. Dept. of Engineering Science started attracting very high JEE(A) rankers, at one time it was the number three department with respect to the option exercised by JEE(A) rankers. It will have to be another article if one has to do justice to the innovations within the Department of Engineering Science, but one can visit <https://es.iith.ac.in/studentsexperience.html>

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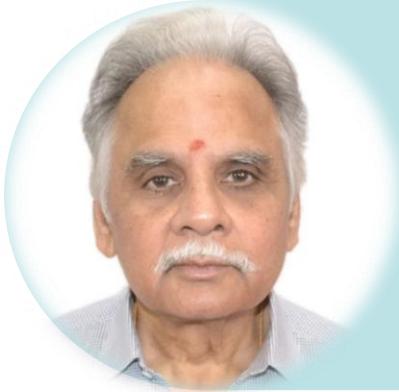
It was decided to have the Department of AI as a virtual department. Another reason for having a virtual department was that today, there are no graduates who have core expertise in AI; they are fundamentally CSE or EE graduates with a Ph.D. thesis in AI. Thus, it is best if these faculty are judged by the standards set by the departments where they have the core expertise (for e.g. CSE or EE) and if found suitable, hired by the core department. They then, of course, can be associated with the Department of AI. The philosophy being that this should continue until one starts having graduates with core expertise in AI. Once the Senate approved the decision for starting B.Tech. in AI and forming a virtual department, faculty from different departments came forward to join the program. Of course, bulk of the faculty were from CSE and EE. Please visit <https://ai.iith.ac.in/index.html>.

Good things started happening as soon as the B.Tech. in AI was established. It was the second most sought after department (after CSE) by JEE(A) rankers, and this in the very first year of offering B.Tech. in AI – the opening rank was 478 and the closing rank was 657. Other institutes and colleges started thinking of a B.Tech. program in AI or AI and DS. Some, with help from IITH started B.Tech. in AI or B.Tech. in AI & DS in 2019 itself. By 2020, almost all institutes of national importance started some program with some permutation or combination of AI and DS. Soon after the B.Tech. in AI was launched by IITH in 2019, AICTE discussed starting such programs in all NBA accredited colleges in the country. Very quickly a positive decision was taken by AICTE to allow B.Tech. in AI and DS in all NBA accredited colleges. IIT Hyderabad can take pride in starting a wave, for programs in AI and/or DS across the country. Today, IITH offers a full

bouquet of programs in AI at the undergraduate and postgraduate level, as well as a minor in AI. Research in all aspects of AI, not just computer vision, is pursued by many faculty and students across departments. In fact, it may not be an exaggeration to say that today, IITH has the best programs in AI and also the best faculty in AI; a small proof of the pudding: Nvidia decided to start India's first NVAITC (Nvidia AI Technology Center) to accelerate research in AI and its commercial adoption at IITH.

Let me end by making a few remarks on starting an innovative program. The key components of starting an innovative new program are:

- (i) The process is both top-down and bottom-up simultaneously, a contrarian approach,
- (ii) Assessment of the need – a slow process requiring a lot of study, a lot of scanning of the global horizon, a small team needs to do this,
- (iii) Consultative – bringing the faculty on board, this is a process that is slow, requires a lot of patience, requires a lot of time from the Director and the faculty, innumerable hours are spent by faculty and the Director in both formal and informal discussions. Perhaps, a lot more is achieved during informal discussions,
- (iv) Having the courage that the program may or may not succeed. If success is the prime criteria, then nothing innovative will be achieved. In any innovative endeavor, one must be prepared for failure.



At present, almost everyone has heard phrases such as Artificial Intelligence (AI), Machine Learning (ML), Data Science, and the like. Courses on these topics abound, both on the Internet and in various types of institutions. Various success stories of AI in image recognition, speech recognition, drug discovery, medical diagnosis, etc. can be found in popular media almost every day. Leading academic institutes such as IIT Hyderabad have introduced specialized programs in AI at all three levels: Bachelor's, Master's and Doctoral. If the experience of our graduates (and those from other top institutions around the world) is any indication, industry is ready to snap up the graduates of these programs at highly attractive salaries.

And yet one can ask: Is the AI revolution (as I choose to call it) a myth or a reality? Have there been precursors to the present wave of interest in AI? If so how did the earlier waves play out?

The phrase "Artificial Intelligence" was coined by the Stanford Professor John McCarthy in 1955. The reader may be surprised to know that there have been at least three such "hype cycles" regarding AI since that time. The first hype cycle centered around what was called the "perceptron" which was invented in 1962 by Frank Rosenblatt. Perceptrons were claimed to match the performance of humans at checkers (or draughts as they are called in some countries). But the hype ended in 1969 with the publication of the book "Perceptrons" by Minsky and Papert in 1969. The book showed very clearly that

perceptrons were incapable of solving some very elementary problems, and sent the book into hiatus for nearly twenty years. During the 1970s, an entirely different approach was initiated, based on using AI to mimic human reasoning. These computer programs were called "expert systems" and were meant to enable novice humans to perform at the level of expert humans, by capturing the knowledge of the latter in a set of "rules." Expert systems were quite good for solving highly structured problems such as diagnosing faults in a radar for example. However, they stumbled when confronted on real-world problems that did not strictly follow the rules of logic, and instead required intuition and judgement. Thus rule-based expert systems never became anything more than niche solutions to specific problems.

The next hype cycle started in 1986 with the publication of a three-part book titled "Parallel Distributed Processing" by Rumelhart, McClelland and Hinton. Rather ironically, this book revived the perceptron, but in a different architecture called Multi-Layer Perceptron Networks (MLPNs). This class of networks are also known as neural networks. MLPNs could solve more complex problems than single perceptrons. More to the point, mathematical theories of "learning and generalization" were developed to explain *why* MLPNs worked so well. I too have written two books on this topic, one in 1997 and another in 2003. Unlike earlier hype cycles, this one did not collapse. Rather, after the initial excitement, the research area went into a quiescent period, awaiting further development.

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The current hype cycle in AI began in the current decade, and much of it is based on "deep learning." Specifically, while the MLPNs of the 1990s consisted of a few dozen neurons at three or four layers, current networks consist of hundreds of layers and millions of neurons. The advances in deep learning can be attributed to three factors, in decreasing order of importance:

1. Massive increase in computing power, exemplified by GPUs (Graphical Processing Units) and TPUs (Tensor Processing Units).
2. Availability of enormous amount of data, to train neural networks.
3. Invention of new algorithms.

Notice that I put the invention of new algorithms at the bottom. I believe that the availability of computing power and of data contributed much more to the recent advances in AI than the invention of new algorithms, though the last item is also important.

So where do we stand today? Will the current hype cycle survive like the invention

of MLPNs, or collapse like the two preceding cycles? My own belief is that it is too early to say. The availability of cheap and powerful computation tempts the user to build overly elaborate networks to solve the problem at hand. As of now, there is ample empirical evidence, and some theoretical evidence, to show that when overly elaborate network architectures are used to solve AI problems, the performance of the resulting networks is often fragile (changes drastically with minor changes in the training data), easily fooled by imperceptible changes in the input data, and other such shortcomings. The theory of "deep learning" lags the practical application at the moment. This is in contrast with the MLPN era when the theory lagged only a few years behind the practice. It does not help that the complexity of current AI systems makes theoretical analysis very challenging. Nevertheless, if the collapse of the first two hype cycles and the survival of the third hype cycle has shown us anything, it is that discipline will survive when it has a solid mathematical foundation. Thus it is imperative for the research community to continue its investigation into the mathematical foundations of deep learning. This is my personal area of research at the moment.



Most disciplines in engineering have evolved based on some fundamental principles, theorems and laws, like the strength of materials, electromagnetics and thermodynamics. But the discipline of artificial intelligence (AI) is evolving without any foundation. We are struggling to define the basis or theory to justify the area as it exists today. To appreciate this, we will briefly recall the history and evolution of AI over the past seven decades. We will discuss current notions of AI and highlight what is missing, for the future generations to ponder. The objective of this article is to dispel the misunderstanding and anxiety, especially among the youngsters, that they are missing something if they do not catch up with it now. In my opinion, by the time they are prime in their careers, either the scope of AI would have changed completely from what it is now, or new area(s) may emerge, making our current thinking of AI irrelevant, as it happened to most of us in our careers. For example, I am not sure how many of us now feel the relevance of most of the material in the books on AI written during the period 1960 to 1990 (eg. Books by Patrick Winston, N.J.Nilsson, Elaine Rich, S.Russell).

The term AI was coined in 1956 at Dartmouth workshop by four eminent mathematicians, John McCarthy (Dartmouth College), Marvin Minsky (MIT), N. Rochester (IBM), and C.E.Shannon (Bell Labs). The organizer John McCarthy said that the deliberations at the workshop “to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence in principle be so precisely

described that a machine can be made to simulate it”. The goal was to understand human intelligence and learning, and not to build a machine to learn and display intelligence the way human does. At that time there was never a focus on building powerful machines for AI.

In an effort to demonstrate by simulation our limited understanding of human way of doing things, it was necessary to develop interpretation of the manipulation of bits in Von Neumann architecture for symbolic operations, instead of numerical operations. The symbolic operations enabled people to simulate the logical inference, which was assumed to be a human trait.

The way people play some of the games is supposed to be a reflection of their intelligence. Hence attention was directed to simulation of games to demonstrate the intellectual activity of human beings through machines. Games were chosen for demonstration of the intelligent behaviour, as it was easy to represent them in terms of states and operators on a machine. Game playing was formulated as a search problem, using heuristics for pruning the search. AI was associated with the heuristics in search. Many real world problems were mapped as search problems, such as speech understanding systems (SUS) and image understanding systems (IUS). But slowly it was realized that mapping a real world problem as a search problem is the real intelligent part of the problem, which human beings were doing with their accumulated knowledge.

Continued...

It was felt that acquisition, representation and invocation of knowledge was the key for simulating the intelligent behaviour of human beings on a machine. Knowledge-based expert systems were developed under the fifth generation computer systems project in early 1980s. But soon it was realized that knowledge of an expert cannot be articulated to extract and represent in the form of rules for an engineer to simulate on a machine.

The AI researchers were desperately looking for an alternative to the knowledge-based systems. They thought they found a way in the emergence of Parallel and Distributed Processing (PDP) volumes by Rumelhart and Mclelland in 1986, which attempt to exploit our limited understanding of the structure and function of the biological neural networks (BNN) to realize computation models that can be used to simulate the intelligent tasks. Several different types of architectures, called artificial neural network (ANN) models, were developed to demonstrate specific pattern processing tasks that reflect some aspects of human learning and intelligence.

But very soon the field ended up in training complex ANN models, resulting in the emergence of three broad categories of learning tasks, namely, supervised, unsupervised and reinforcement learning. The focus shifted to capturing the implicit relations in large volume of data. With the availability of computing power and data, the attention was more on developing algorithms to capture the pattern information in the distribution of the data. Machine learning took the centre stage, and the original AI goal of simulation of learning and intelligence behaviour of human beings has been relegated to the background, along with the idea of building ANN models for

specific pattern recognition tasks.

The availability of large volumes of data and huge computing power with storage has increased by several orders of magnitude in the past decade. This enabled people to develop large complex nonlinear models to capture the implicit patterns or relations or mappings in the input data. The complexity of these models is mostly in terms of number of parameters defining the model. A few varieties of models, such as CNN, VAE, GAN and LSTM, are conceived to cater to different types of data and problems. All these models are grouped under the generic name of deep neural networks (DNN), with associated deep learning for training. Note that DNN is simply a nonlinear computing model. It has nothing to do with the BNN in terms of structure or function. The deep learning refers to adjusting the parameters of the model. Deep learning has no significance either of learning or of the depth of learning. It is also interesting to note that deep learning is not even a task like supervised, unsupervised and reinforcement learning, all of which have no links with any particular architecture or model.

DNN with associated deep learning is a powerful computational model, which can be exploited for several sophisticated tasks for which large volume of data is available for training the model. One must acknowledge the power of these models in addressing a variety of practical problems to obtain meaningful predictions from the data.

Most of these tasks are currently interpreted as AI tasks, although no concept of AI, such as learning or intelligence is involved in it. It is also apparent that there is hardly any innovation possible for understanding human learning and intelligence, as envisaged by the pioneers of AI.

Continued...

Those familiar with the evolution of the scope of AI over the decades are amused at the current trends in describing AI as a superset of machine learning, which in turn is viewed as a superset of deep learning. Careful observation indicates that machine learning involves a set of algorithms for executing the tasks which are directly linked with data-driven problems. Likewise, DNN is a nonlinear model with large number of parameters, which can be determined only with large volume of data and huge computing power. There is tremendous potential for these models with many commercial benefits. But calling them as AI problems, and trying even to come up with explanation (explainable AI) for the intermediate stages of computation is far from the way humans do these tasks.

Once the applications using these models become a commonplace, it is likely that the attention may switch back to understanding the human way of doing things, especially in the domains of learning, knowledge and intelligence. It is important to see the complementary roles of human intelligence and machine intelligence. While human intelligence involves pattern processing using the BNN, machine intelligence involves data processing using computational models. Human intelligence is concept-driven, whereas machine intelligence is computation driven. The dichotomy can be expressed in several ways. My explanation is that humans process the data first and then represent it in their memory, whereas machines represent the data first (samples, pixels, numbers, etc) and then process. Some of the obvious attributes of human

intelligence are selective attention mechanism, stability-plasticity, continuously reconfigurable BNN architecture, and dealing with variety of data situations. The more we make an attempt to understand these issues, the less we will know on how to describe them for implementation or simulation on a machine.

In this AI journey over decades, a few scientists and philosophers have been alerting on the hype being created on several occasions. Marvin Minsky's books on Perceptrons in 1969 and 1988, and Hubert Dreyfus's books on What computers (still) can't do in 1972 and 1994, are eye-openers in this context.

Current AI is technology-driven, and not concept-driven. While we wait for clearer perspective of AI to emerge in the light of the current developments, it is necessary to explore and exploit the potential of the evolving technology for many practical applications. It may not be wise for us to freeze the scope of AI in terms of these developments, as the scientific community is unable to guess what the next wave would be like in this evolution.

In conclusion, it is apt to quote C.E.Shannon about the limitations of the current computing models for displaying intelligence. "Efficient machines for such purposes as pattern recognition, language translation and so on, may require a different type of computer than any we have today. It is my feeling that this will be a computer whose natural operation is in terms of patterns, concepts and vague similarities, rather than sequential operations on ten-digit numbers". Claude E. Shannon

Research Diary

An assortment of work underway @IITH
in the field of AI
*(Arranged in the alphabetical order of
author's name)*



Resource allocation for adaptive video streaming with machine learning-based subjective quality of experience

Dr. Abhinav Kumar,
Dept. of EE

Our research focuses on utilizing machine learning and resource allocation for improving the quality-of-experience (QoE) for video streaming users over a wireless network. The video streaming in mobile environments is challenging due to the time-varying nature of the wireless channels and is affected by the fluctuating network conditions. Given these factors, it is important that the wireless networks perform careful management and optimal utilization of the available resources such that the video streaming users' demands are met to the best possible extent without degrading their QoE. The Dynamic Adaptive Streaming over HTTP (DASH) standard provides a media delivery framework that allows video users to adapt over different bitrates according to the varying network conditions so that an uninterrupted playback is maintained. However, it often results in a user video quality that keeps varying with time. Moreover, the video playback buffer can run out of the content resulting in rebuffering events. Both time-varying quality and rebuffering affect the perceptual QoE of video users. In this work, we have addressed the problem of understanding and modelling the streaming QoE as perceived subjectively by the users. Streaming QoE modelling is challenging as it is continuous, dynamic, and

time-varying in nature.

Hence, the QoE must be evaluated in a continuous manner so that suitable actions can be taken at the network controller such as eNodeB in cellular networks to minimize the QoE degradation of the video users. Various machine learning models like support vector regression QoE (SVR-QoE), C3D time-varying subjective quality (C3D-TVSQ), non-linear state-space QoE (NLSS-QoE), and long short-term memory QoE (LSTM-QoE) based models have been considered.

Given the benefits offered by the QoE-centric methodologies for video streaming in cellular networks, we propose Video Quality-of-experience Aware Resource Allocation (ViQARA), a QoE-centric method for allocating resources to the video users in LTE cellular networks. In ViQARA, the potential of the proposed machine learning-based QoE models are leveraged for resource allocation. A comparison between ViQARA and the conventional throughput based resource allocation indicates that a significant improvement in the average QoE levels, as well as the reduction in the average rebuffering times of the video users, can be achieved with ViQARA.



AI @ Advanced Embedded Systems and IC Design Laboratory

Dr. Amit Acharyya,
Dept. of EE

I. Compression Methodology for CNN Targeting Resource-Constrained Edge Devices

In this study we proposed a fragmented

Huffman coding methodology, that can be applied to the binary value equivalent of the numeric weights of a neural net model when stored in hardware memory.

Continued...

Huffman compression technique has been revisited by applying it on binary files, from a hardware design perspective, based on multiple bit pattern sequences, to achieve a maximum compression rate of 64 %. This is followed by a compressed hardware memory architecture and the decompression module design which has been synthesized at 500 MHz, using GF 40-nm low power cell library with a nominal voltage of 1.1V achieving a reduction of 62 % dynamic power consumption with a minimal single module decompression time of about 63 microseconds without trading-off accuracy.

[Funding Acknowledgment - DRDO, NPDR (DST, SERB, Govt of India), Redpine Signals Inc.]

II. Development of See-through Armour for Defence

We propose to develop an agile situational awareness prototype model that will employ advanced monocle and imaging technology, providing soldiers with a 360-degree, real-time view outside of their combat vehicles. External optical sensors operating in normal vision or infrared feed imagery to either a helmet-mounted display that synchronizes with head movements and stitches together a complete picture of the battlespace or plugin a tablet display to view 360 degrees to digitally collate, map, and classify various features on the battlefield to track their environment. Better knowledge of surroundings brings increased combat effectiveness and survivability, enabling safer route planning, speedier communication and information sharing, and more rapid targeting. In addition, soldiers can share what they are seeing with other crew members or their commanders to boost response time.

III. Reconfigurable Machine Learning Accelerator

DEEP neural networks (DNNs) are extremely popular and have been adopted to solve problems in a wide variety of fields, including image recognition, semantic segmentation, language translation, and autonomous driving. DNN inference is currently performed on a range of traditional computing systems, including CPUs, field-programmable gate arrays (FPGAs), and GPUs, which provide different

tradeoffs between efficiency, cost, performance, and programmability. CNN algorithms and designs are developing rapidly, however, the low-level operations such as convolution, pooling, activation, etc. remain the same. Hence, we are working for the reconfigurable ML accelerator on which varying shapes and sizes of CNN can be implemented.

The proposed accelerator will be efficient, parameterized and run-time configurable hardware architecture with high-level parallelism and efficient memory designs to support various networks that fit into various FPGA platforms. In other words, we like to design a hardware/software co-designed library to efficiently accelerate an entire CNN on FPGAs. *[Funding acknowledgement - DRDO]*

IV. Intelligent metal corrosion detection based on Acoustic Emission (AE) signals.

Acoustic Emission (AE) signals are sound waves, generated by the rapid release of energy from a localized source within a material when it is stressed. These localized sources of stress wave include different types of defect in metals like cracks, pits, corrosion etc.

Continued...

These stress waves travel through the material and captured by the AE sensors placed over it. The stress wave from the sources mentioned above has some specific unique feature which will be identified and characterized. These real-time characterized AE signals from material (High strength steel) along with simulated AE signals from simulation software like Ansys will be pre-processed and mixed with noise (real and simulated) like different environmental conditions, work as an input to train the neural network. This trained neural network model will be used to predict the type of defect which can classify the defects due to different causes, and ageing of the sample. This customized deep learning model will work efficiently for the specific task as mentioned above. This model will be compact and of less size, so it can work on a mobile platform and require less computation power. [Funding Acknowledgment – Naval Research Board (NRB) and IMPRINT-II]

V. IoT Based Holistic Prevention and Prediction of Cardiovascular diseases and Assistive Technology

Cardiovascular diseases (CVD) are the leading cause of deaths across the world. Recent years have witnessed a growing interest in developing personalized and non-hospital based care systems to improve cardiac care consequently to reduce morbidity and mortality.

Electrocardiogram (ECG) is the only easy to use diagnosis tool useful for assessment of the probability of cardiac arrhythmias. Clinical CVD diagnosis is generally carried out using the standard 12 lead system.

However, recording all the 12 leads is often difficult, cumbersome and impractical considering the high memory, bandwidth and data transmission time & power in remote health care systems. Moreover, a

reduced lead system with 2-3 leads is generally utilized in the telemonitoring application, which is not significant for clinical diagnosis. To bridge this gap, we are researching towards reconstructions methodologies, where a single channel ECG will be recorded from transmission end and all the remaining leads will be reconstructed at the receiver end, thus limiting the bottlenecks mentioned above. For this reconstruction methodologies, we are using data-driven deep learning approaches using Convolutions neural networks (CNN) and LSTMs (Long short term memory). While convolutions extract the inherent features adaptively, LSTMs are useful to extract the temporal dependency, thus maximizing the performance of the reconstruction. Apart from this ECG to ECG reconstruction, we are also working on Photo plethysmograph (PPG) to ECG reconstruction. PPG is a non-invasive technique which records the blood volume changes happening due to cardiac pumping of the blood using optical techniques and very low-cost technology than for ECG. Moreover, the patient has to wear a minimum of 3 electrodes on the body to get one lead of the ECG where PPG can be recorded from a single sensor placed on the wrist or fingers. With the intuition of PPG correlates with ECG and considering the advantages of PPG over ECG, we started working on PPG to ECG reconstruction methodology. Here also we follow the same data-driven deep learning approaches using CNN and LSTMs.

This research work is partly supported by Department of Science & Technology (DST) under the Internet of Things (IoT) Research of Interdisciplinary Cyber-Physical Systems (ICPS) Programme, GOI, New Delhi, with the Project entitled “IOT Based Holistic Prevention and Prediction of CVD (i-PREACT)”.

Continued...

[Funding Acknowledgment – MEITY-IoT for Smarter Healthcare project; DST-ICPS Project; Xilinx Inc., USA; SERB-ECR and MEITY-SMDP-C2S]

VI. Machine Learning techniques to build a cost-effective framework for fault-tolerant training of RRAM based neural computing systems.

An RRAM-based computing system (RCS) is widely used in neuromorphic computing systems due to its fast computation and low cost. However immature fabrication processes cause a high rate of hard faults. Also, the limited endurance of RRAMs

restricts the life of RCS. We are using Machine Learning techniques to build a cost-effective framework for fault-tolerant training of RRAM based neural computing systems. Physical design flow is an extremely time-consuming process when it comes to optimizing the designs. Due to multiple back and forth within the flow makes it a heavily time-consuming process and increases the turn around time of the final product. We are using ML and AI to reduce the turn around time and the cost. *[Funding Acknowledgment – DRDO ERIPR Project]*



Reforming Video Analytics Prof. C. Krishna Mohan

**Dept. of CSE &
Dean (Public & Corporate Relations)**

In recent years, the amount of visual data in the computer vision community is proliferating due to the reducing size and increasing reach of sensors. The understanding and analysis of visual data is hence indispensable to solve various computer vision tasks. We, VIGIL group at IIT Hyderabad, focus on cutting-edge visual understanding tasks includes surveillance video analytics for smart cities, fine-grained action recognition, spontaneous facial expression recognition, scalable and distributed methods for large scale visual computing, remote imagery analysis on satellite and radar data, a semantic description of video activities, autonomous vehicle technology, weather forecasting using a live camera, radar and satellite data, content-driven advertisement insertion, as well as anomaly detection in fine-grained actions. We focus on solving various computer vision tasks by constructing a

semantically meaningful representation of videos. Our recent collaborations have included projects with OPPO India to address video blurring and de-duplication of images, as well as with Weathernews, Japan, to address the problem of precipitation now-casting by analyzing weather and road scenes. We have harvested datasets such as SkyEye, IITH-accident database (IITH-AD), and IITH-1 to investigate road user's collision behaviors. SkyEye dataset was introduced to detect collision prone vehicle behavior at intersections and contains 1 hour of continuous aerial footage from 4 major intersections in the city of Ahmedabad in India. IITH-AD and IITH-1 are captured from surveillance videos to investigate road traffic accidents. Our research has resulted in direct application and deployment in real-world applications, as well as publications at top-tier venues of high impact.



Computational methods for Tele-monitoring of heart health

Prof. C. S. Sastry,
Dept. of Mathematics

Tele-monitoring of heart health involves two steps - monitoring specific health parameters and communicating the data with the specialist (See Figure-1 for details). Cardiovascular conditions require the monitoring of multiple parameters such as heart beat, blood pressure etc., and reliable and meaningful diagnosis can be obtained only by judiciously combining these various results.

First-generation tele-cardiology systems were made of hand-held ECG machines that could be hooked on to the patient like a regular ECG machine and the results were transmitted in their entirety to the specialist for diagnosis. The drawback is that only the experts at the receiving end of the data would be able to detect abnormalities from the large amount of data transmitted to them. What if the detector system at the patient's site could analyze the data as it was acquired, and directly communicate only anomalies/problem areas to the specialist, instead of the entire data?

The collaborative work of Dr. S. Jana, Dr. B.S. Chandra and Dr. C. S. Sastry at IIT-Hyderabad has developed algorithms (computer programs) for two purposes - one for the extraction of abnormal signals from ECG data and transmit them to a remote expert, and the other, for combining blood pressure and ECG data into a meaningful output that is easier for the expert to diagnose.

In the first case, their effort, with cardiology guidance by Dr. Laxminarayana Anumandla, a cardiac surgeon from Maxcare Hospital,

Warangal, has resulted in an algorithm that not only detects abnormal heart beat in the ECG, but also compresses this data so that it can be sent easily over limited bandwidth internet, such as those in rural areas. For this, the researchers have used a data compression and classification algorithm called "Dictionary-based categorisation and compression" (See Figure-2 for details). The compressed data can be easily decompressed and interpreted at the receiving end. This algorithm has been shown to have a low error rate - maximum of 1 undetected beat per 100 heartbeats. It also reduces the cost of bandwidth by 99.15%, accounting for 118-fold savings over first-generation tele-cardiology. An added benefit of this type of tele-monitoring is that the workload of the specialist is reduced by at least 85.9% for noncritical cases because the expert has to look only at the anomalies that have already been extracted by the algorithm.

In the second study, the IIT-H research group has developed a procedure by which they can combine data from multiple physiological signals - in this case, they have combined the ECG data with blood pressure data - to predict heart health. In real life, cardiologists do not rely on results of a single test (say, ECG) to look for heart diseases; instead, they look at multiple biometric parameters such as blood pressure and plethysmogram signals, and by experience, they know how to combine the various parameters to arrive at the health status.

Continued...

The group has mimicked the human thinking process involved in analyzing and combining multiple input data into a realistic output, in using a form of computing system called Artificial Neural Networking (ANN). ANN, a rudimentary form of Artificial Intelligence (AI), obtains multiple inputs and “learns” through training steps to recognize patterns and anomalies, to process them into a reliable and accurate output. The team has used a form of ANN called Convolutional Neural Network (CNN). The CNN-based information fusion (CIF) algorithm is generalizable, robust and efficient in detecting heart characteristics from multiple input parameters.

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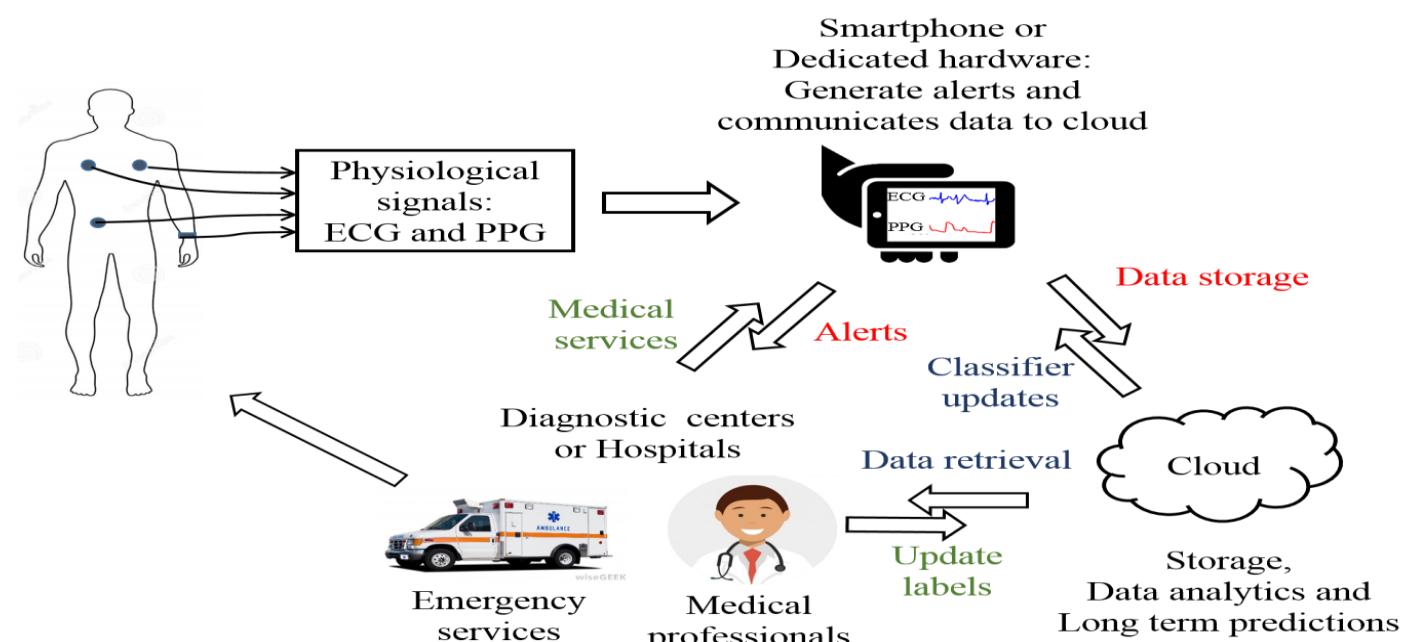


Figure 3: AI based tele-monitoring of heart health

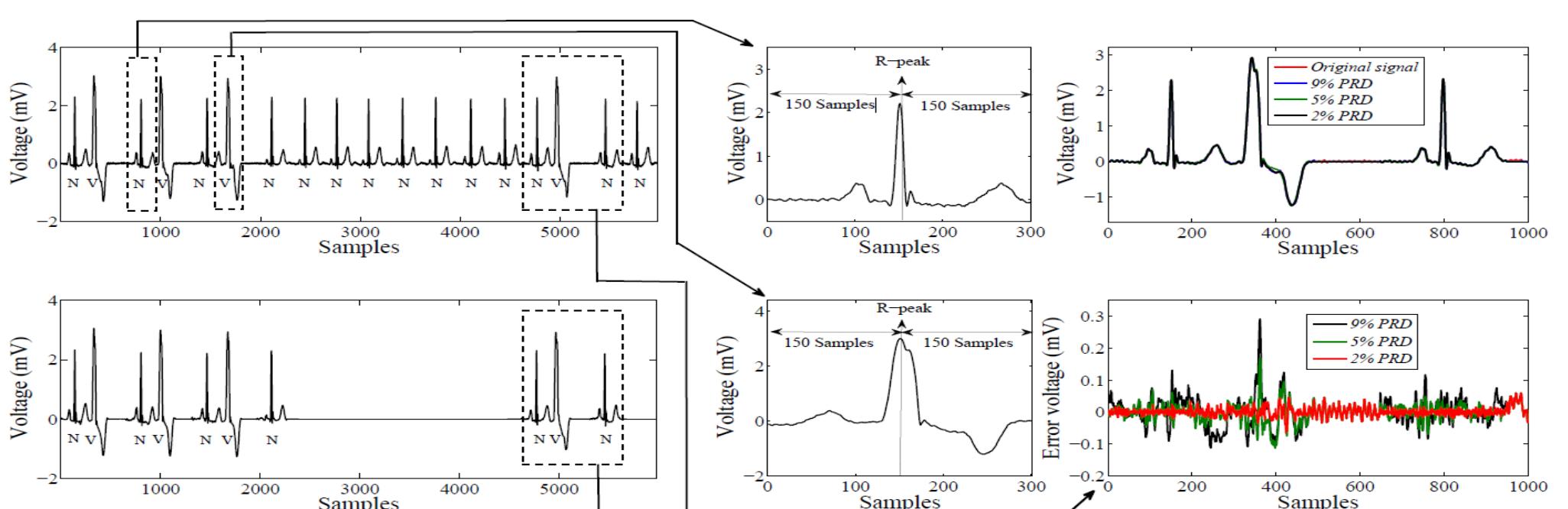


Figure 4: Dictionary-based categorization and compression



Dimensional Collapse in the Continuum Limit of Large Networks

Dr. C. P. Vyasarayani, Dept. of MAE

Neural networks are large interconnected dynamical systems. These networks are capable of learning and reproducing a verity of complex tasks. In our latest published research:

Vyasarayani, C.P., Chatterjee, A. Complete dimensional collapse in the continuum limit of a delayed SEIQR network model with separable distributed infectivity. *Nonlinear Dynamics* (2020).
<https://doi.org/10.1007/s11071-020-05785-2>

A time-delayed network model relevant to modeling the spread of infections among the population segregated based on their infectivity has been studied. We demonstrated that in the continuum limit when the number of nodes in the network becomes infinite, low-dimensional behavior emerges. This work has direct applications to modeling the spread of COVID-19, and work is underway to use the model for predicting the infection among different countries.

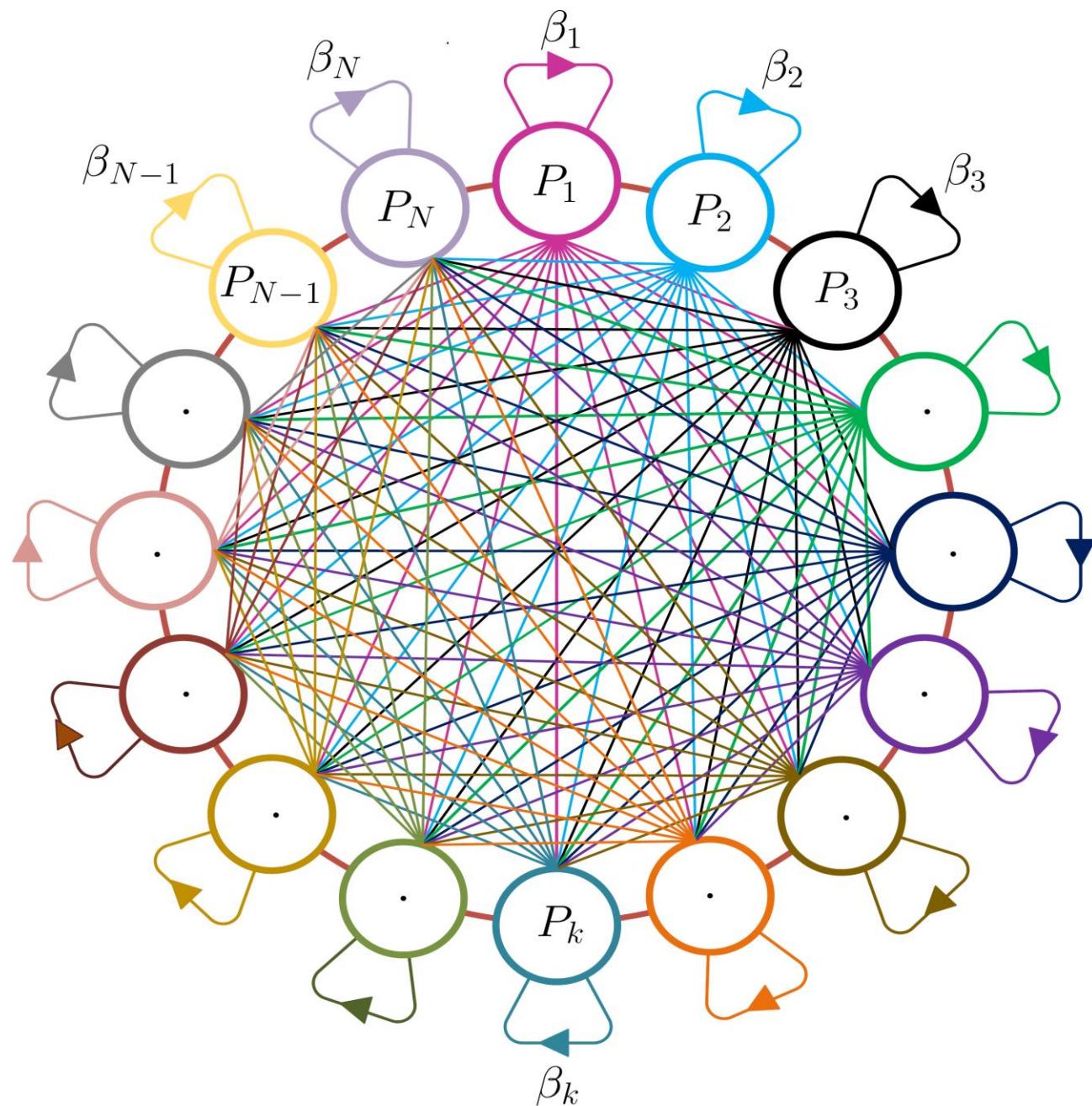


Figure 5: A schematic representation of N interacting population groups with different infection spread rates among each group. Every connection between two groups is bidirectional and symmetric, and every group is connected to all other groups (a dense network).



Recent improvements in state-of-the-art experimental and computational infrastructures, affordability, automation, ubiquitous connectivity through IoT, a global push towards meeting environmental constraints to ensure safety and sustainability resulted into generation, processing and management of enormous amounts of heterogeneous data in the domain of Process Systems Engineering (PSE). PSE, which deals with the process design for the purpose of converting raw goods to usable end products, focuses on the design, operation, control, optimization and intensification of chemical, physical, and biological processes. Our aim @ GOKUL is to develop state-of-the-art data tools that can cater to the special needs for vast amounts of highly complex data generated by the PSE community.

We target potential areas in PSE and investigate how the applications of deep supervised/unsupervised learning methods based on artificial neural networks (ANN) can be made useful there. Exploiting the novel multi-objective evolutionary Neural Architectural Search technique developed @GOKUL, TRANSFORM \square , we could successfully show how (i) optimization of computationally expensive models can be improved multiple folds using surrogate models (ANN), (ii) accurate system identification and data-based model predictive control of extremely nonlinear industrial processes can be performed (RNN, LSTM), (iii) image-based sensing can be improved for better optimization of the process (CNN, AE, VAE), (iv) the uncertainty quantifications for nonlinear models using analytical derivations can be obtained through Sobol indices and global sensitivity analysis (PUNNs), (v) the ideas of approximation of control vector using ANNs

can be utilized to solve complex single and multi-objective optimal control problems efficiently, (vi) fuzzy clustering performance can be improved by neural networks based reformulation for identification of global optimum and (vii) generative modelling can be utilized to accurately solve the industrial nonlinear multi-objective optimization problems in uncertain framework (GAN, VAE). Our targeted applications include wind farm layout optimization, new alloy discovery by enhanced computational materials science calculations, monitoring environmental parameters due to climate change, smart sensing of particulate matter, fast-charging protocols in Li+ battery management, bio-fuel supply chain optimization, systems biology (cell classification based on Ca+ oscillations in neurons), chemical engineering (polymerization reactors), metallurgical engineering (steel making processes etc.), mineral processing (grinding and flotation) and mechanical engineering (uncertainty analysis in supersonic flow of tactical missiles, surrogate optimization using CFD models) applications. Apart from the desired tangible benefits, some of these results brought laurels to GOKUL as they were bestowed with the best paper award in the international platforms (e.g. ACODS in 2020) and highlighted as works which can open up new opportunities to explore new designs in future (e.g. BATTERY 2030+, a long-term roadmap for forward-looking battery research in Europe, prepared by the EU Horizon 2020 initiative mentions our work in the Li+ Battery space). We acknowledge the collaborations with universities in USA, UK and funding agencies (UKIERI, MHRD, DBT, DST, DRDO, Tata) for their support.



NLP, Social Network Analysis and Recommendation Systems

Dr. Manish Singh,

Dept. of CSE

My research group focuses on research problems in the area of NLP, Social Network Analysis and Recommendation Systems. We focus on applied data science research. My group has worked on data from community question-answer (CQA) sites such as StackExchange and Quora; product reviews from e-commerce sites such as Amazon and Yelp; and social media data from sites such as Twitter and Facebook. Following are few sample problems that we have worked on and published recently -- Finding the top-k CQA sites for posting a given question; Finding whether a given question is tagged well or not; Recommending experts who would be willing to answer a given question; Summarizing and tagging product reviews;

Analyzing factors of social media to maximize information diffusion; Summarizing social media posts. To enhance users' navigation through huge volumes of data, we have been exploring personalized and context-based recommendation systems. In 2019, my first PhD student Nagendra Kumar graduated with his PhD in the area of Social Network Analysis. At present, he is working as an Assistant Professor in the Computer Science Department in IIT Indore. My other graduated students have also been working as data scientists in organizations such as Yahoo! Japan, Rakuten in Japan, Walmart Labs in Bengaluru, A*STAR in Singapore.



Automated generation of Natural Language Text

Dr. Maunendra Sankar Desarkar

Dept. of CSE

Automated generation of questions and answers are helpful in various scenarios such as reading comprehension, conversational systems, focused retrieval, knowledge graph enrichment etc. Even for humans, generating questions or answers from a specific input context requires high cognitive skills and thorough understanding of the language. Automating the task is hence even more challenging. However, recent advancements in NLP related to semantic understanding of text has made it possible to address many of the challenges that are common in these problem settings, and has given rise to newer problems in this area. Our research group works on problems related to such understanding and

generation of natural language texts.

One way to assess the language understanding capability of the readers is to test their comprehension skills - ask them to read a piece of text, and then ask questions to verify how far they have understood the text. Use of multiple-choice-questions (MCQs) is a commonly followed technique for reading comprehension – as it requires pointed response from the candidates, and automating the evaluation becomes easy. In MCQs, generally there is one correct answer, and there are a few incorrect answers. Given a passage, a question, and a correct answer, multiple incorrect answers can be listed by the instructors.

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However, if the generation of these incorrect answers can be done in an automated manner, it will be quite useful – as it will save time for the instructor, and different sets of incorrect answers can be shown to different candidates. However, it is very much necessary to ensure that the generated incorrect answers (called distractors) are in the context of the questions, and they are not semantically equivalent. Otherwise, they can be easily eliminated by the test taker. We are working on automatically generating such grammatically correct long distractors for reading comprehension tasks.

Automated generation of correct responses and appropriate follow-up questions are at the center of conversational systems. It requires correctly understanding the intent of the questions, and also keeping track of the entire conversation as the user can

specify his/her complete requirement in multiple turns. We are developing algorithms that can keep track of such dialogue states and ask/answer appropriately to understand the complete requirement.

Thorough understanding of textual content can be helpful in many ways. Social media posts generated during disasters often carry ground-level information from the affected regions. Efficient retrieval of such posts generated during can give actionable insights regarding the effect at specific regions, the requirements of resources (food, water, medicines, blankets etc.) at different locations, the efforts of different NGOs and individuals. All this information can be quite helpful in the planning rescue and relief operations significantly, and mitigate the suffering of the people in the affected regions.



Natural Intelligence & AI –
Spinal Cord and Movement Laboratory
Dr. Mohan Raghavan
Dept. of BME

Most popular AI and ML algorithms from the perceptron to CNNs have been inspired by principles of computational neuroscience. Our lab works on building large multiscale simulations of the spinal cord, muscles and skeleton to achieve movement using biological mechanisms across scales. Using the in-silico movement platform NEUROiD built in our lab, we explore methods by which our brain learns to manipulate the spinal circuits in order to achieve the desired movement.

In the context of AI, we use this platform in order to understand the general algorithms that underlie movement circuits in nature. If

one may think of the muscle and skeleton as a natural robot, the spinal cord is a robotic controller that constantly adjusts drive and works in a closed feedback loop with the natural robot. The brain can similarly be thought of as a reinforcement learning system that uses the natural robot along with the spinal controller to achieve a movement. The tautness in muscles informs the brain of the internal state of the robot. Our eyes and sense of touch provide the rewards to the brain, telling them whether a movement is desirable or not.

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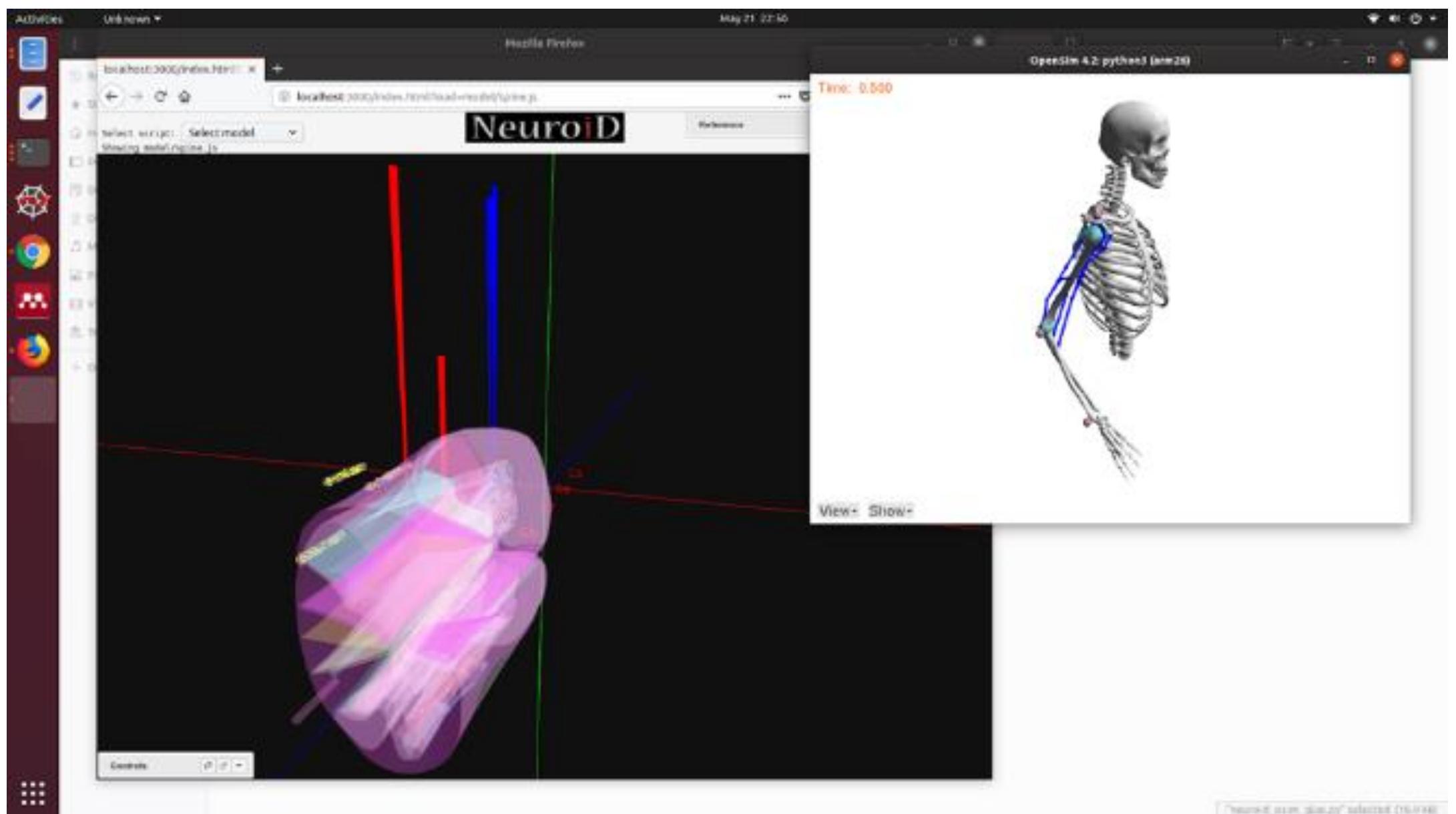


Figure 6: A screenshot from the NEUROiD in silico movement platform with the spinal cord controller(left) and the natural robot - a human hand (right)



Drone Based Sensing and AI Driven High-Throughput Phenotyping for Agriculture

Prof. P Rajalakshmi,

Dept. of EE, Dean (Students) & Team in collaboration with ICRISAT, Hyderabad and PJTSAU, Hyderabad

In recent years, automation, imaging solutions have paved the way for many high throughput phenotyping studies in agriculture. In the current scenario, the standard phenotyping methodologies (i.e., manual observations or laboratory assessments) are costlier, time-consuming, labor-intensive, destructive, and are frequently not standardized. Semi-automated systems have also been applied

to investigate various components of plant growth and development, thus contributing to crop improvement programs. Researchers used ground-based platforms like handheld, fixed position static cameras, ground-based imagery sensors to capture the images of the crop fields. However, the field of view of the static cameras is minimal, and hence these techniques are not widely adopted in the real-time scenario.

Continued...

In recent times, the usage of unmanned aerial vehicles (UAV) equipped with cameras and sensors have become very popular in remote sensing and monitoring applications. The UAVs equipped with cameras can have a wide field of view with broad coverages, and also have advantages such as low cost, easy deployment, and high spatial, as well as temporal resolutions when compared to airborne or space-borne remote sensing. Recently, non-invasive methods, based on

UAV imaging techniques such as RGB, multispectral, hyperspectral, IR cameras, etc. are used to study the anatomical and physiological traits like crop health, crop nutrients, disease tolerance, water stress, crop yield, etc. Figure 1 using AI/ML-based algorithms. The workflow for High Throughput Phenotyping through UAV-based on-board sensors is shown in Figure 2.

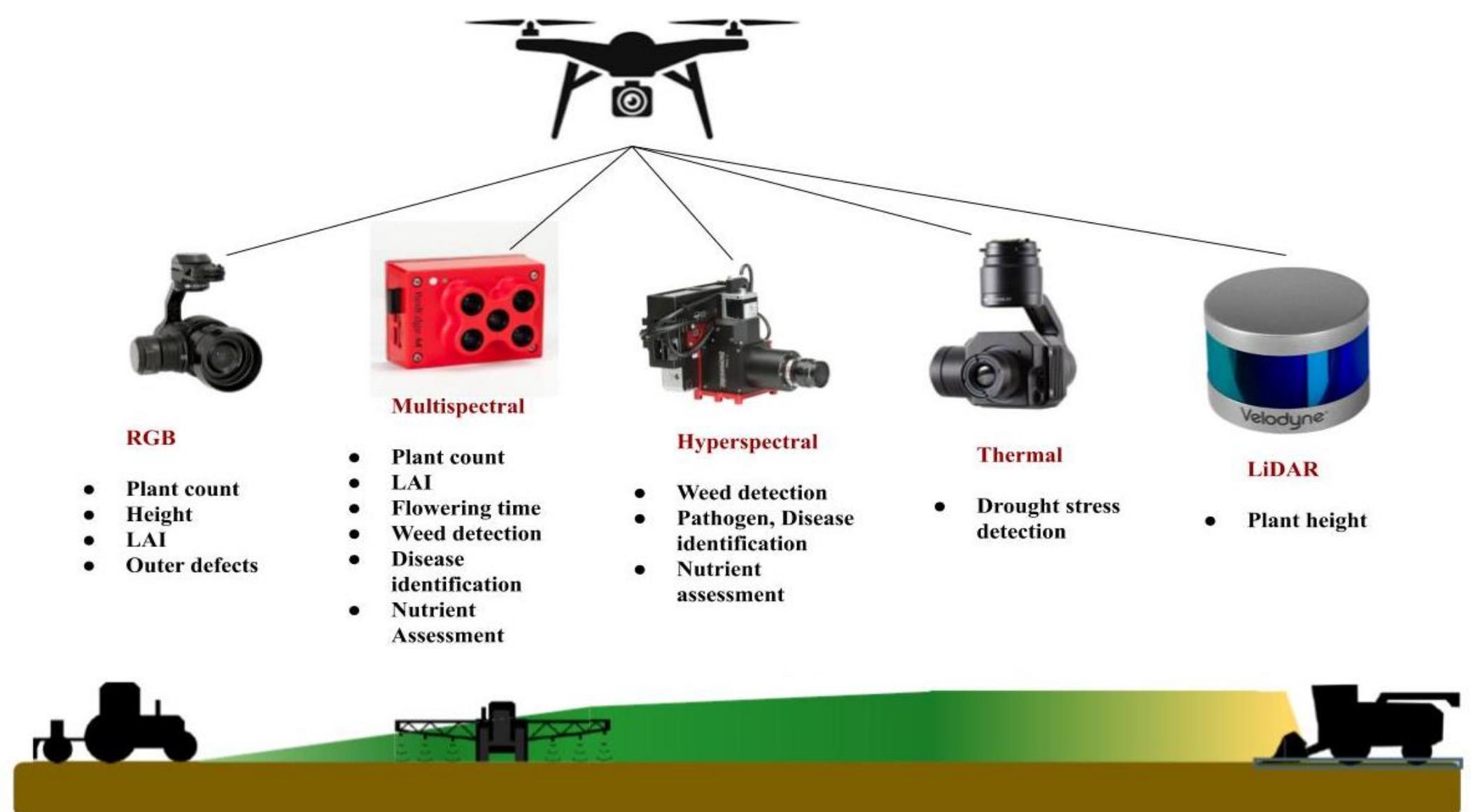


Figure 1: Sensors integrated with UAV and their application in Agriculture

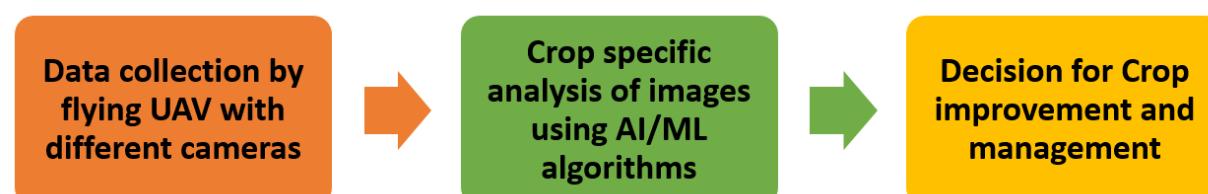


Figure 2: Workflow of High Throughput Phenotyping through UAV



I am working in the general area of mobile robotics, with emphasis on legged robotics. Robots that move on two or four or six legs are particularly useful in traversing rough terrains where wheeled mobile robots face difficulties. Biped/humanoid robots are preferred in civilian environments due to their adaptability to tools/structures used by humans. Bipedal robots are much more unstable compared to quadruped and hexapod robots. My current research focuses on the walking stability of biped robots for

extreme cases of walking such as taking long steps, for instance, over ditches. We have successfully generated stable joint trajectories for large steps using genetic algorithms offline and using mechanics and control based algorithms in real-time. Dynamic walking with double support phase under actuator faults is another research area we are pursuing. Further, I also work on navigation and controller development for autonomous passenger drone.



Snippet of AI Research from Saidhiraj Amuru

Dr. Saidhiraj Amuru

Dept. of EE

Every technology usually takes around 10-15 years from the conception phase to research and ideation phase and finally to the implementation phase. 5G was initially conceived when 4G LTE was being developed and networks were starting to be deployed around the world. 5G is now being developed in most places except for small pockets of deployments around the world. Going by the current trends of technology development now is the time to think about 6G. 6G is touted to be the technology that connects humans and machines in a more deep-rooted fashion than 5G. One question that arises is what is 6G going to be? 6G can comprise of many technical innovations – terahertz communication, intelligent surfaces, artificial and machine learning equipped wireless networks among others. My research in 6G focuses on the

applications of machine learning for wireless communications. We study ML-enabled methods to make wireless networks intelligent that cater to the ever-increasing demands of connectivity and data deluge. Some of the problems we work on include downlink precoding for multi-user connectivity in a decentralized broadcast network, addressing the performance loss due to delayed or stale feedback by employing prediction-based algorithms, massive user scheduling in practical cellular networks where each user experiences different channel conditions, and has varied traffic requirements, indoor and outdoor localization using channel state measurements, human activity detection using WiFi measurements, physical layer security among others.

Continued...

In each of the research problems we study, we first understand the theoretical underpinnings of each problem using the vast wireless communications literature available from over 70 years of research in these areas. Later, we employ various tools from machine learning, spanning from supervised, unsupervised, self-supervised and reinforcement learning techniques, to achieve improved performance at their respective tasks that were previously possible only in select settings. While not stopping at performance, we also delve deeper to understand why certain deep learning algorithms tend to perform well while others do not. For example, in this regard, we studied what kind of neural networks must be used to perform well at a certain task under different kinds of wireless channel models such as AWGN, Rayleigh

fading, or channels with memory. Most of the problems we work on require the students to have good knowledge of wireless communication fundamentals as well as hands-on experience with machine learning tools.

At IITH, I introduced a course on machine learning applications for wireless communications, the first such course in academia across the world. As part of this course, we learn how modern machine learning techniques are applied to solve a variety of problems in wireless communications. Some of the projects done by students in this course have resulted in publications in prestigious venues. We are constantly looking for motivated students, both undergraduate and graduate-level to contribute to this upcoming field of research and make fundamental contributions.

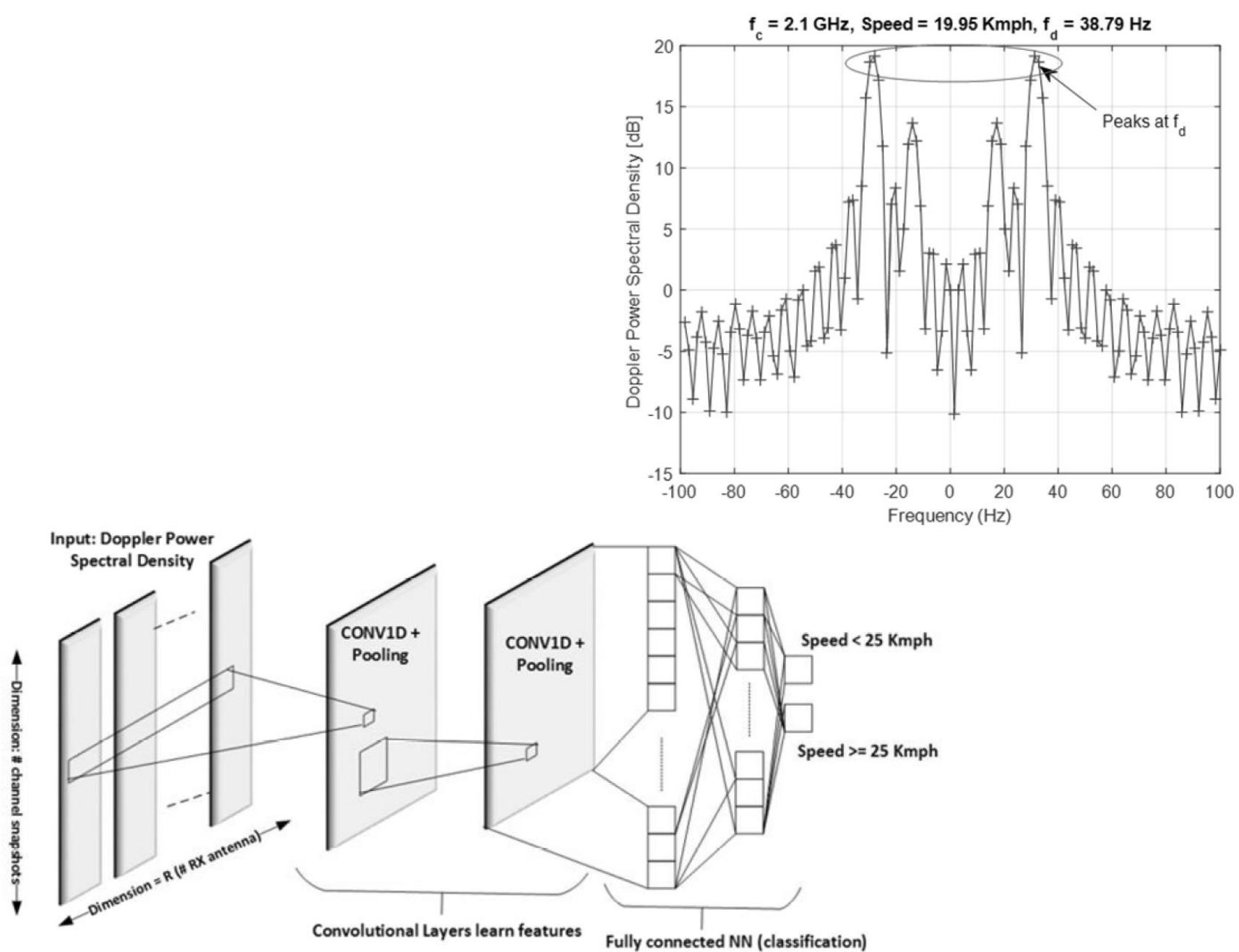


Figure: 8 Using deep learning tools to predict the speed of a mobile equipment (i.e., phone) using channel measurements



Application of tools from Information theory (AIC, BIC, DIC, WAIC) and Bayesian Statistics

Dr. Shantanu Desai,

Dept. of PHY

Working on applying tools from Information theory (AIC, BIC, DIC, WAIC) and Bayesian Statistics to problems in model selection for a variety of problems in astrophysics and cosmology. Some datasets to which I have applied these techniques include residual event rate data from direct dark matter detection experiments, expansion date measurements using cosmic chronometers, residual torque date from Eot-Wash experiment in University of Washington etc.

References:

[1] Model Comparison of Λ CDM vs $R_h=ct$ using Cosmic Chronometers

H. Singirikonda and S. Desai Eur. Phys. J. C 80, 694 (2020)

[2] Model comparison tests of modified gravity from the Eöt-Wash experiment
A. Krishak and S. Desai, JCAP 7,006 (2020)

[3] Robust model comparison tests of DAMA/LIBRA annual modulation
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[4] An independent assessment of the significance of annual modulation in COSINE-100 data A. Krishak and S. Desai, Open Journal of Astrophysics 2, 1 (2019)

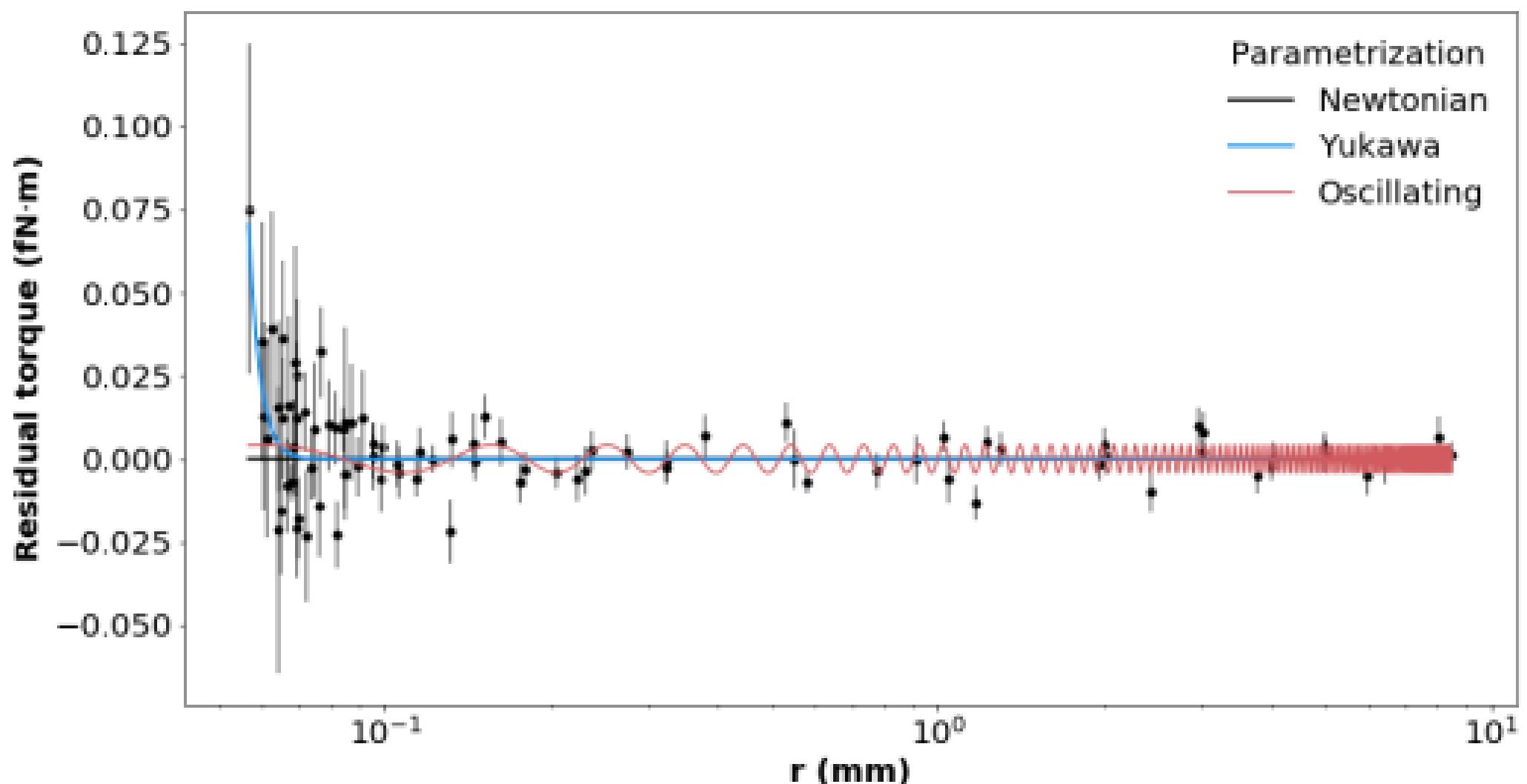


Figure 8: Residual Torque Variation



“Iudicium Posterium Discipulus Est Prioris” - Every day is a student of the previous day! We are in the era of big data, where a large amount of data is generated in the form of text, images, and videos. This deluge of data calls for automated methods of data analysis, and machine learning became a very successful approach to automatically learn from data. My research work aims to develop machine learning techniques for analyzing data from varied domains such as computer vision, language processing, and social networks. I am also interested in applying machine learning to problems arising in science and engineering disciplines like mechanical, civil, physics etc. We develop machine learning models inspired by the way human learning works. Towards this end, we use Bayesian learning, stochastic processes, differential equations and neural networks to develop novel machine learning algorithms. Though deep learning has brought advances in artificial intelligence, they are incapable of modelling uncertainty and are less robust which cause adverse effects in high-risk applications such as autonomous driving vehicles and disease diagnosis. Moreover, they require a large amount of training data and have a cumbersome model selection process. We develop next-generation deep learning models which can overcome these drawbacks with the help of Bayesian non-parametric approaches, for instance, convolutional deep Gaussian processes. We also work on developing Bayesian deep learning models for safe artificial intelligence, natural language processing and continual learning, a fast emerging topic in AI which aims to learn like humans in a continuous manner. Another research interest is on social network analysis, where we aim to develop techniques which can mine information and model activities

arising in social media. We developed a system to aid people in disasters such as floods and earthquakes and provides information on resource availability and requirements in real-time. The work received appreciation from government agencies and is covered by various newspapers. We also work on developing statistical models which can predict the behaviour of users in social media like their posting times and can learn the implicit network of influence between them. These models are naturally explainable and interpretable unlike black-box deep learning models and can be useful for a wide variety of problems. We hope to develop learning algorithms and models which are useful not only for artificial intelligence but also in general for problems arising in science and engineering. Please find more information about us in the Bayesian Reasoning And INference (BRAIN) webpage (<https://sites.google.com/view/brainiith/home>).

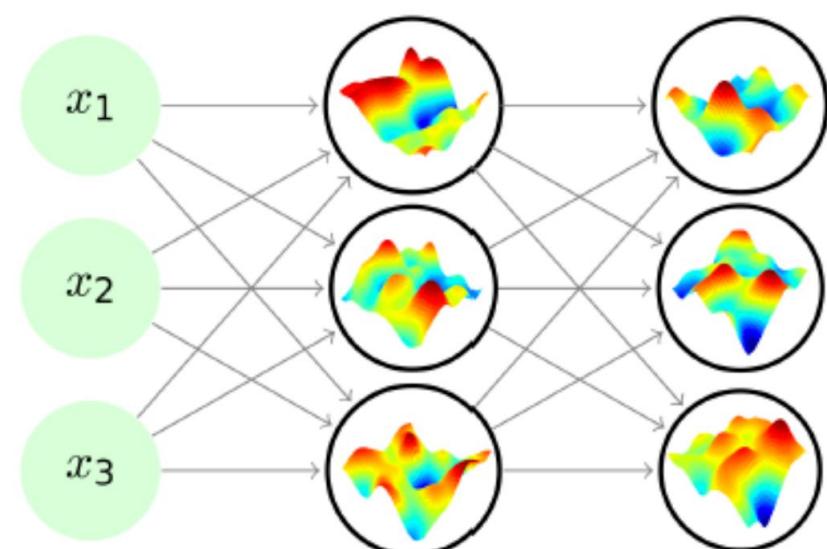


Figure 9: Bayesian deep learning model



Quality Aware Generative Adversarial Networks

Dr. Sumohana Channappayya,

Dept. of EE

Generative Adversarial Networks (GANs) have become a very popular tool for implicitly learning high-dimensional probability distributions. Several improvements have been made to the original GAN formulation to address some of its shortcomings like mode collapse, convergence issues, entanglement, poor visual quality etc. While a significant effort has been directed towards improving the visual quality of images generated by GANs, it is rather surprising that objective image quality metrics have neither been employed as cost functions nor as regularizers in GAN objective functions. In our work, we show how a distance metric that is a variant of the Structural SIMilarity (SSIM) index (a popular full-reference image quality assessment algorithm), and a novel quality-aware discriminator gradient penalty function that

is inspired by the Natural Image Quality Evaluator (NIQE, a popular no-reference image quality assessment algorithm) can each be used as excellent regularizers for GAN objective functions. Specifically, we were able to demonstrate state-of-the-art performance using the Wasserstein GAN gradient penalty (WGAN-GP) framework over CIFAR-10, STL10 and CelebA datasets. We call our proposed framework Quality Aware Generative Adversarial Networks (QAGANs). This work was carried out by PhD Scholar Ms. Kanchala Parimala. For more information (including the related publication and code), please visit our lab LFOVIA website at <https://www.iith.ac.in/~lfovia/publications.html>



3D Printing: Connecting the Virtual to Real

Dr. Surya Kumar S.,

Dept. of MAE

Artificial intelligence is often linked to the ability of a machine to solve a given problem by itself, without human intervention, based on data and past experiences. In this regard, 3D Printing serves as a critical link in the physical translation of a virtual perception. 3D Printing is a process for making a physical object from a three-dimensional digital model, typically by laying down many successive thin layers of material. It brings a digital object (its CAD representation) into its physical form by adding layer by layer of materials. When AI is combined with 3D printing, it can lead to not just automated

production but automated manufacturing process planning adaptable for a different set of shapes and geometries; imagine just having to give the CAD model and the machine figuring out the process steps, tool paths, online monitoring and final part fabrication. Today with the help of 3D Printing, one can make parts, appliances and tools in a wide variety of materials right from your home or workplace. Using a computer, simply create, modify or download a digital 3D model of an object. Click "print," just as you would for a document, and watch your physical 3D object take shape.

Continued...

The pedagogical uniqueness of IIT Hyderabad in this area is looking at 3D printing as a basic skill, capable of radicalizing design and fabrication, instead of relegating it to be a tame elective. Every undergraduate student who joins IITH is introduced to 3D printing/digital fabrication technologies right in the first year. The course is divided into two parts viz., (1) CAD modelling and (2) Project on 3D printing. It is expected that this will become the backbone of all future design and fabrication initiatives of the students. Also, exposing the students to cutting edge technologies right in the beginning catches their fascination and involves them in the creation of products of high technological value right from the beginning.

On the research front, the focus has been on integrating the manufacturing constraints into the computational and optimization

stages of the design. In the 3D Printing, it is crucial to ensure that not just the process, but the process planning too is optimized. The Design for Additive Manufacturing paradigm integrates the 3D printing constraints into the design process. This is achieved by incorporating additive manufacturing-specific constraints like the material continuity, anisotropic modelling and support material optimization into the topology optimization process. This not just ‘improves’ the process, but makes it possible to create components with tailored properties. The illustration shows an example of a gradient density shoe sole based on pressure distribution. The component is fabricated in such a manner that it has a different pressure response at different locations, compensating for the pressure variations seen on a foot.

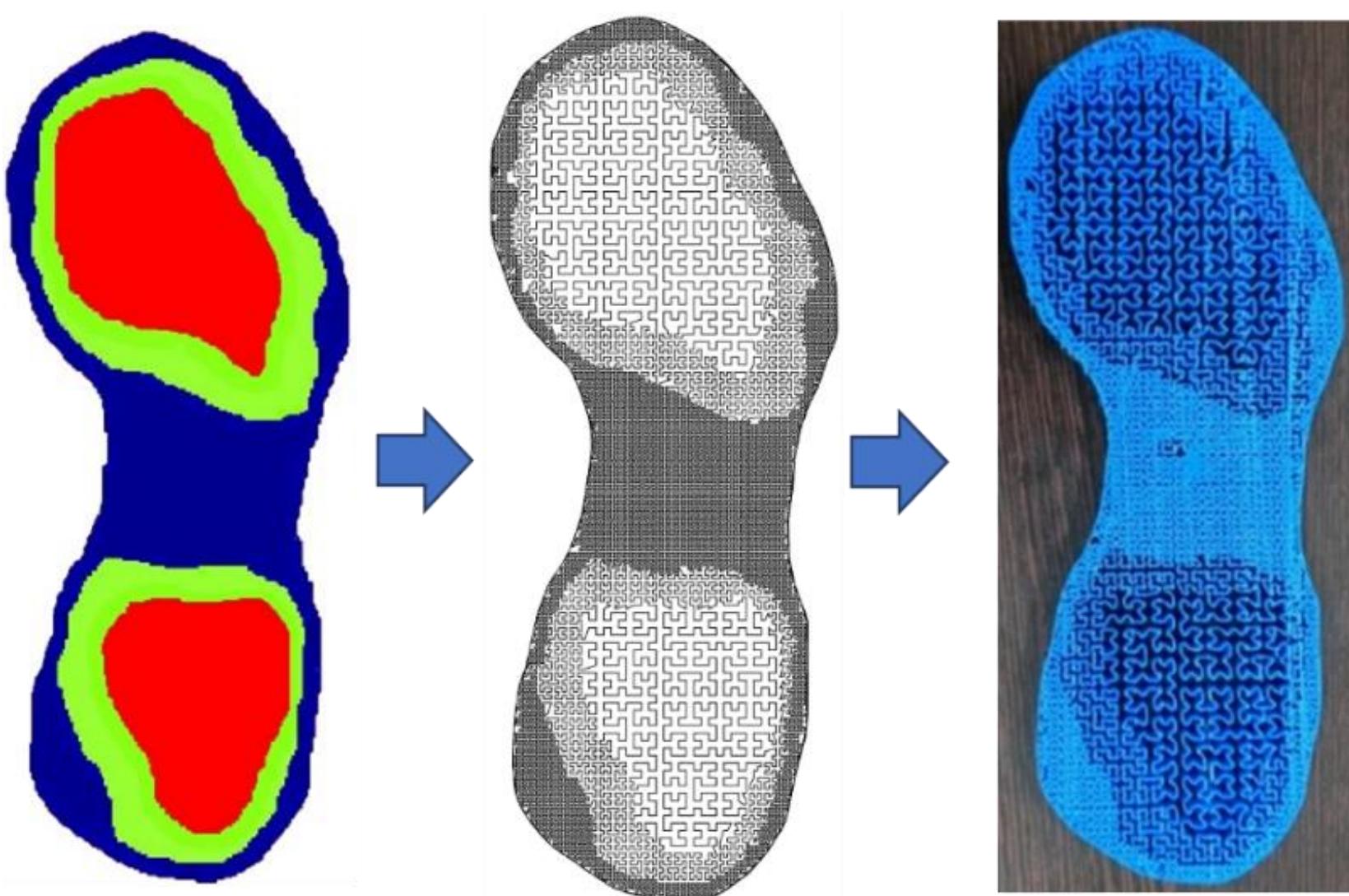


Figure 10: 3D printing shoe sole with gradient density tailored to for variable pressure distribution



Towards Label-Efficient, Explainable Deep Learning

Dr. Vineeth N Balasubramanian,

Dept. of CSE, HoD - AI

Our research group on “Machine Learning and Vision” at IIT-Hyderabad works at the intersection of the theory and application of machine/deep learning - with a focus on applications in computer vision. With a strong interest in the mathematical fundamentals and a passion for real-world application, our group aims at being at the forefront of the field, by carrying out impactful research in the areas of deep learning, machine learning and computer vision, guided by application contexts derived from real-world use. Our problems of interest in recent times have focused on:

- Learning with limited supervision (or) Label-efficient learning: This includes problems such as zero-shot learning, few-shot learning, continual learning, active learning, domain adaptation, domain generalization; and
- Explainable machine/deep learning: This includes problems on use of causality in machine learning, adversarial and attributional robustness, disentanglement of latent variables.

We are also broadly interested in the theoretical understanding of deep learning, and making deep neural networks faster (to train and test), as well as smaller. From an application standpoint, problems of our recent interest include applying the

algorithms we develop to domains such as:

- Agriculture: E.g. Plant phenotyping using computer vision;
- Drone-based vision: E.g. Detection of objects from drone imagery, as well as low-resolution imagery;
- Autonomous navigation: E.g. Adding levels of autonomy to driving vehicles in developing countries, focusing on India;
- Human behavior understanding: E.g. Detection of emotions, human poses, gestures, etc of the human body using images and videos

The algorithms developed in our research have been used for explaining COVID-19 diagnosis in chest X-ray images, finding defective cells in solar arrays, explaining cancer prediction on gene expression data, identification of pathogens in tomograms, leaf counting, genus classification in plant images, etc. Alumni of our group have gone on to join Google AI Residency, Facebook AI Residency, Harvard, Max Planck Institute, and other reputed institutions around the world. We invite you to please see <https://iith.ac.in/~vineethnb/index.html> or <http://lab1055.cse.iith.ac.in/> for more information on our research interests, projects, and publications.

Students Diary

Snippet from the life of an AI Student
(Arranged in the alphabetical order of course & author's name)



My name is Bhat Dittakavi and I am a second-year Ph.D student from the Artificial Intelligence department at IIT-Hyderabad. I have more than two decades of technology entrepreneurship experience. Using technologies such as analytics for solving business problems has been my passion. My research areas of interest include building computer vision-based technologies for fitness and wellness.

Building AI technologies that address real-world problems in fitness training and wellness is a problem worth solving. Worldwide, more than 2 billion adults are overweight. The solution is fitness and healthcare that have global appeal. Fitness market for Yoga and Pilates alone is expected to reach \$215 billion by 2025. Previous efforts in this area have been largely limited to analysing sensory data from hand-held or hand-worn devices. Works were done in exercise analysis using deep learning very rudimentary. AI works done for action recognition in sports are limited to very few such as basketball and cricket that have lots of demand and hence some funding. Currently, no AI research leverages vision and language for real-time training for personal fitness purposes. Our ultimate long-term objective is to build something like Alexa with eyes.

My thesis work is aimed at exercise pose analysis for real-time fitness training. There are two major challenges here. Somebody parts blocked by some other body parts make it hard for the AI system to recognise the type and correctness of the pose. This occlusion problem is hard as the AI system has no knowledge about the parts that it can't see. We are running various experiments using different deep learning

methods whose collective wisdom might help solve this problem partially. The second challenge is about the response time of the system. As the person in front of the mobile camera performs the exercises in sequence, our system has to quickly identify the correctness of the poses being done and also localize and correct the body parts or region where the exercisers are getting it wrong. This requires our deep learning models to be very light-weight, quick in analysis and interpretation. EfficientNet and MobileNet are some of the state-of-the-art deep learning networks meant for mobile applications. We are evaluating how these methods can be adopted for exercise pose analysis.

Finally, human pose estimation, i.e. identification of x and y coordinates of 18 skeletal joints, is the natural starting point to recognize actions involved with humans. State-of-the-art human pose estimation methods are limited to action recognition datasets that are built for sports. Most of these methods don't address the occlusion well. On top of it, adopting these methods for exercises such as Yoga and Pilates is challenging as we don't have any datasets available. We are parallel working on building a yoga pose dataset for Surya Namaskar (Sun Salutations) workout that would be of immense help to us.

In summary, we are building a yoga dataset for running our own CNN based experiments and working on coming up with novel methods for occlusion handling and pose correction in exercise. Our future work will include building an AI-based visual dialogue system using CNNs and RNNs that enable it to have a dialogue with the exerciser in real-time in exerciser's native language.



"Creating a Brain out of a Brain From mind-boggling to mental conditioning"

Shristi Gupta

(M.Tech - AI)

Mind conditioning is like the Rate Determining Step of a reaction. The most time taking. But, unavoidable and essential. Well, I'm an engineer so I make the above statement through my experiments in permutations and combinations of circumstances. To be really honest, I was sceptical about studying in IIT, considering a failed attempt in joining it for bachelors, despite the efforts, owing to technical glitches, to be able to match up, to be able to survive the pressure. But, one year later, here I am writing this article, as an IITian. It definitely is a pressure cooker, but for all good reasons. I think that is what IIT does to you, it induces performance, it will grill you until you push your limits until you put your best foot forward. Till last semester as an M.Tech, in AI, getting back to studying after corporate life and trying to cope up my health and ongoing competition with the changed cuisine and climate, I thought surviving here would be a mammoth task. It still is. But, the mindset has changed. I've started to enjoy the pressure. I tried to take one step at a time, slowly and consistently.

I read it somewhere, that consider life as an hourglass, the sand doesn't go all together down, it goes some particles at a time, the decision of which particles would go down depends on either destiny or your efforts. And until all sand settles at the bottom, we have to take one day at a time. So, I started putting my best efforts each day. Inquisitiveness was the driving force to study, I studied because I liked studying, but somewhere in the race for marks, this inquisitiveness and liking took a back seat. But, once it was put back in the driver's seat, things got on track and went on smoothly. I used to sit for courses, prioritizing the sheer will to learn. This metamorphosis took time but happened. Also, managing my interests in sports and EML made it a little

complicated. But, I do not regret being involved in them. If coursework was taking care of my technical skills, EML took care in honing my personality and sports took care of my physical and mental strength. I'm glad I ended up at IIT and got those opportunities and the right people to support me in the form of friends, seniors, juniors, professors, counsellors. Sure enough, I haven't achieved much, I'm still hustling, but a battle won in the mind makes plans easier to crystallize. It's the process that is important.

Why did I choose AI?

Why would I not? It's creating a brain out of a brain. It's a branch of engineering that could couple with any other branch and produce astonishing results. It's interdisciplinary, its impact projection is large, it has maths, it has coding and it has domain acumen. Surviving in a century that has devices and data all around AI is the next big thing. Professionally, I wanted to be in a career, where technology channelizes resources for development where needed. AI finds its applications everywhere. You name it, you have it. Let's consider a simple example, we have a tailor X and he stitches for rupees 20 per hour and works for 10 hours a day, making it to 200 rupees a day, costing manual labor and at times inaccuracy. Now, we handover a stitching machine to this Mr. X, the accuracy and time to stitch shoots by five times making it 100 rupees an hour, Plus the machine can be used in a cycle of 10 hours each with a break of 2 hours in between. So making up to 2000 rupees a day. Surprising right? This stitching machine is metaphorically AI. Yes, one might say that this is a product of mechanical engineering or product design domain. I am not opposing that. But, what about the tailor's intellect to know what to cut, where to cut? What about creativity?

Continued...

What about learning with experience? How can you bring that? One can definitely cannot completely imitate the human brain and its intricacies, but some parts of it can be imitated through AI, that is the beauty of it, that is what I am glued on, it can sit on top of anything and enhance the process. One definitely cannot completely imitate the human brain and its intricacies, or can we? Albert Einstein once said, "There is not the slightest indication that nuclear energy will ever be obtainable." and here we are running major economies on nuclear power. Can we really achieve artificial general intelligence? If AI can help us achieve par-human performance in healthcare applications and beat champs of complex games like Go then the so-called technological singularity is pretty much a possibility. This is what inspires me to study AI.

Little bit Technical.

To be able to put this phenomenal domain into action, one needs the right technical skillset, this is taken care of by the coursework, learning about optimization, hardware implementation, machine learning methods, stochastic processes, reinforcement learning, representation learning, deep Learning, surveillance video analytics, natural language processing etc. I am excitedly looking forward to my thesis this year. I am keen on working in the medical domain, where even a little accuracy increase can impact hundreds. We have medical data in eclectic forms of signals, images, texts, video etc and using Neural Networks depending on the problem statement, we can make sense of this data to find abnormalities beforehand or the degree of medical issues in them. Moreover, drug discovery is a new horizon to explore yet an important one, COVID crisis has only reemphasized its importance. I am right now on a literature survey for the above domains. As a recent project, under the able

supervision of Professor Vineeth N Balasubramanian, I studied the nature of loss surfaces, qualitatively, quantitatively, visually, theoretically.

For a machine learning practitioner, the importance of loss surface cannot be ignored. It determines how well your model learns and how accurate would the results be. There have been several optimization techniques to mitigate the stochasticity of gradients and move from non-convexity to convexity, not getting stuck in saddles, local minima or plateaus. Analysis of loss surfaces has been through hessian spectral density, double derivation methods, experimentally playing with hyper parameters, etc. Skip connections and batch normalization techniques are proven to work in bringing convexity to loss surfaces, which helps in generalization and reaching correct hyper parameters for optimization. I have also worked on a project that uses natural language processing through gated CNNs that predicts the sentiment of a review. On a personal level, I have worked on a customer segmentation model through purchase history, that helps in prioritizing campaigns and discounts for customers through businesses, I tried to work the pipeline in Big Data. I am now preparing for placements and simultaneously working on my thesis under the able guidance of Prof. Sumohana Channappaya. I endeavor to come up with beneficial outcomes in the work and match my guide's expectations. I want to make the most of the research culture, the commendable expertise of professors and the discussions with colleagues before I graduate from IIT Hyderabad.



This is Jyotshna. I completed my B.Tech 1st yr and am currently pursuing my second year in AI at IIT Hyderabad. I feel honored to be one of the students studying AI in this prestigious institution and would love to share my experience with AI at IITH.

Indian Institute of Technology, Hyderabad is the first among the IITs to start a B.Tech program in "Artificial Intelligence". The teaching faculty appointed for AI is the best and experienced at the IITH.

like all the other branches. The courses taught here as a part of the B.Tech 1st-year curriculum laid a really strong foundation on AI and a strong intuition of what is AI, why is it so useful, what kind of demand it has etc., Courses taught in 1st-year serve as the foundation and overview of the field AI. Most importantly, every course learned as a part of academics (not only AI) are interlinked with each other. As we proceed further in our courses (like Statistics, Probability, Signal Processing, Machine Learning etc.,) we find a deep link between them. In our first year itself, we got the opportunity to learn and make a basic drone like a quadcopter, which is really exciting and practical.

The fascinating thought of mere metal pieces capable of carrying out a complex series of actions automatically made me choose this branch over the others. Since my high school, I was interested to learn about technological hardware and that's when I became fond of robotics. After going through the curriculum of AI at ai.iith.ac.in, it stimulated me to proceed towards my interest in the career I dreamt off.

As far as my journey of a year at IITH is concerned, I feel this is the right place to turn my dreams into reality and the faculty, curriculum, academics here are amazing.

The captivating and inspiring part of AI here is the project making every semester, which makes us learn new things out of the box (on our own which is what every student requires). I didn't have much knowledge of what AI is before I entered IITH. In just a year I feel it laid a really strong foundation for my career. With the knowledge I gained in my 1st year, I can start learning the most in-demand skills like Machine Learning, Data Science etc., on my own. I could even relate my academics to real-world applications like Recommendation- Systems in Amazon etc., In future, I expect to learn more and more practical applications from my academics and faculty.

Bachelor's Degree in Artificial Intelligence at IIT Hyderabad is definitely one of the best choices available for students aspiring a career in Technology out there.

Thank you for this opportunity!



Hey, I am Vikas currently perusing my B.Tech in artificial intelligence.

Life at IIT-H: Life at IIT-H is the perfect amalgamation of fun and studies. While the classes and assignments keep me busy during the morning and late nights, the rest of the day allows me to pursue my hobbies and interests. Many of my friends also find peace in playing cricket and volleyball in the hostel grounds, while some of us head to the Student Activity Centre to play Badminton or go for a swim.

Faculty: A major attraction of IITH is its renowned faculty. Most members of the faculty are achievers in their own right as well as excellent teachers and mentors. I love the fact that our professors are research scholars themselves and deeply involved in their subjects of interest. The attitude of our professors is admirable, and that really makes the IITH journey worth it.

Why did I choose AI: I choose Artificial Intelligence because this topic is very fresh in the computer market. So, it gives us a try to contribute to this New World. World of AI is just Amazing...!

AI is an amazingly interesting study area. It's mix computer science, cybernetics, philosophy, economics, biology and chaos theory or fuzzy logic together.

Goal: What can be a person's ultimate goal? To serve this world. Right? And AI gives you that clearly.

"It gives you a priceless happiness to make a human not by the traditional way, by the help of algorithms and electronics."

Campus Corner

Glimpse of last quarter's happenings...



April, 2020

IIT Hyderabad supported local community against #COVID19 by providing nearly 100 liters of #handsanitizers to Sangareddy District Administration. It is made by a team led by Dr. Jyotsnendu Giri, Associate Professor, Dept. of Biomedical Engineering

April, 2020

IIT Hyderabad & DST-NM-ICPS Technology Innovation Hub on Autonomous Navigation & Data Acquisition Systems (UAVs, RoVs) to jointly offer 2-year M.Tech in Smart Mobility, effective from Aug'2020. For details visit <https://iith.ac.in/mtechadmissions/>

M.Tech in Smart Mobility

IIT Hyderabad and DST-NM-ICPS Technology Innovation Hub (TIH) on Autonomous Navigation and Data Acquisition Systems (UAVs, RoVs) Jointly offers 2 Year M. Tech program on Smart Mobility.



Departments Involved



- Artificial Intelligence
- Civil Engineering
- Computer Science Engineering
- Design
- Electrical Engineering
- Mathematics
- Mechanical and Aerospace Engineering

April, 2020

IIT Hyderabad announces its first set of 8 Interdisciplinary, Unique & Industry oriented M. Tech. Programs effective from 2020

Programs:

- Energy Science and Technology
- Smart Mobility (Joint Program with DST-NM-ICPS Technology Innovation Hub (TIH))
- E-Waste Resource Engg. & Mgmt. (Joint Program with Centre for Materials for Electronics Technology (C-MET) & supported by Mett'l)
- Integrated Sensor System
- Medical Device Innovation (Joint with Asia Institute of Gastroenterology, Hyderabad)
- Network & Information Security
- Polymers & Biosystems Engineering
- Additive Manufacturing (Supported by DRDO)

Eligibility:
MHRD/Govt. R&D Lab or Public Sector sponsored/ self sponsored

For more details please visit:
<https://www.iith.ac.in/academics/post-graduate/>

IIT Hyderabad is calling for applications for its first set of eight #interdisciplinary unique & industry-oriented M.Tech programs. The Last date to apply is 30 April 2020. For more information, visit - <http://iith.ac.in/academics/post-graduate/>

May, 2020

IIT Hyderabad is going to collaborate with New Frontier Capital Management, a financial firm based in Hong Kong, to create a global network of #Venture Ecosystem and also to establish 'Joint Innovation Centers' in Tokyo, Japan, and Telangana State



May, 2020

CII in partnership with IIT Hyderabad launched Power talks with IIT Professors & Industry Leaders. The first Power Talk on "Excitements & Challenges in Nano Science & Technology" was given Prof. B. S. Murty, Director, IIT Hyderabad

May, 2020

Prof. B. S. Murty, Director, IIT Hyderabad, speaks to @IndiaScienceTV on 'Combating #Coronavirus Through Technology' in which he outlines various Research & Development Projects underway at IIT-H



May, 2020

Career Development Centre @IIT Hyderabad has organized a session on “Your Brand on LinkedIn-The Digital You” by Mr. Varun Jain, A/c Director-Large A/cs LinkedIn on 16-05-20, exclusive for IITH students to gain knowledge & insights for the career ahead.

May, 2020

The 3rd Session @CIIEvents - @IITHyderabad Power Talk Series. held on 16th May 2020 by Prof. P. Rajalakshmi, Dept. of Elec. Engg., IITH on “Drones in Connected World”.

May, 2020

MHRD | Government of India
Ministry of Human Resource Development

#COVID19

IIT HYDERABAD

steps up for its villages adopted under **Unnat Bharat Abhiyan** begins relief programmes for them



IITHyderabad has supported villages adopted under Unnat Bharat Abhiyan during #COVID crisis by sharing awareness material with community stakeholders in Telugu & providing them essentials like sanitisers & masks.

May, 2020

IIT Hyderabad's Liberal Arts Dept. organized an Online Conference for Employees & HR on "Employee Engagement & Welfare - In the New Normal of Work-From-Home, Post COVID-19"



Taking stock of the WFH situation
Ms Bindu Venkatesh
VP - Human Resources – Oracle India.
Previous experience: IBM, GE Health Care, Infosys, Volvo and MICO Bosch.

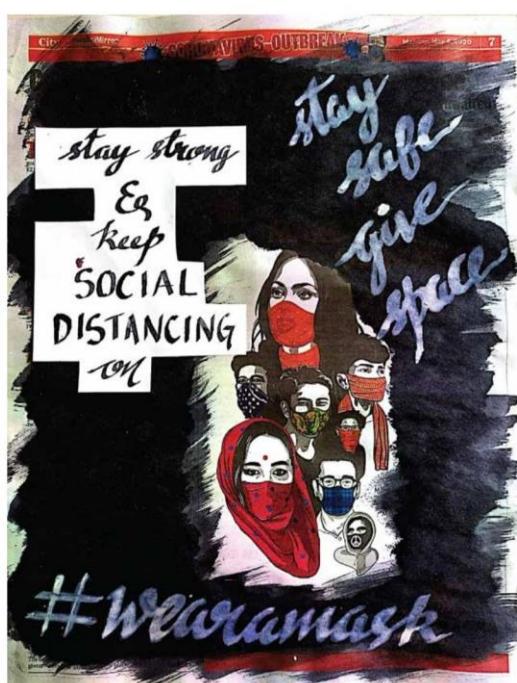
Workplace Support System & Engagement:
An Ecosystem View Dr Rajiv Noronha
VP & Head HR (Analytics & Insights Unit), TCS
Adjunct Faculty at the IIM-Kozhikode
Fellow at IIM Ahmedabad

WFH & Work-Life Balance
Dr Ravi Modali
Practices Lifestyle Medicine using digital health & telemedicine

WFH & Time-Space Conundrums
Dr Jeyavelu
Dean of School of Business, VIT-AP University, AP
Adjunct faculty in many IIMs and other Top B-Schools

Organising Team and Event Link
meet.google.com/khg-mint-eur
Details also available at iith.ac.in
Contact: Sriram
la17mphil11005@iith.ac.in

June, 2020



IIT Hyderabad released Issue-2 #CombatingCOVID-19@IITH of क्रीIITH - The Crowning Glory, a quarterly e-newsletter of IITH. Issue covers all initiatives taken at institute to fight against COVID-19. Link:
<https://iith.ac.in/about/newsletters-iith/>

June, 2020

Going Green @IIT Hyderabad in line with the theme for World Environment Day-2020, 'Time for Nature,'. Planted a total of 20 tree saplings (Neem & Bauhinia).



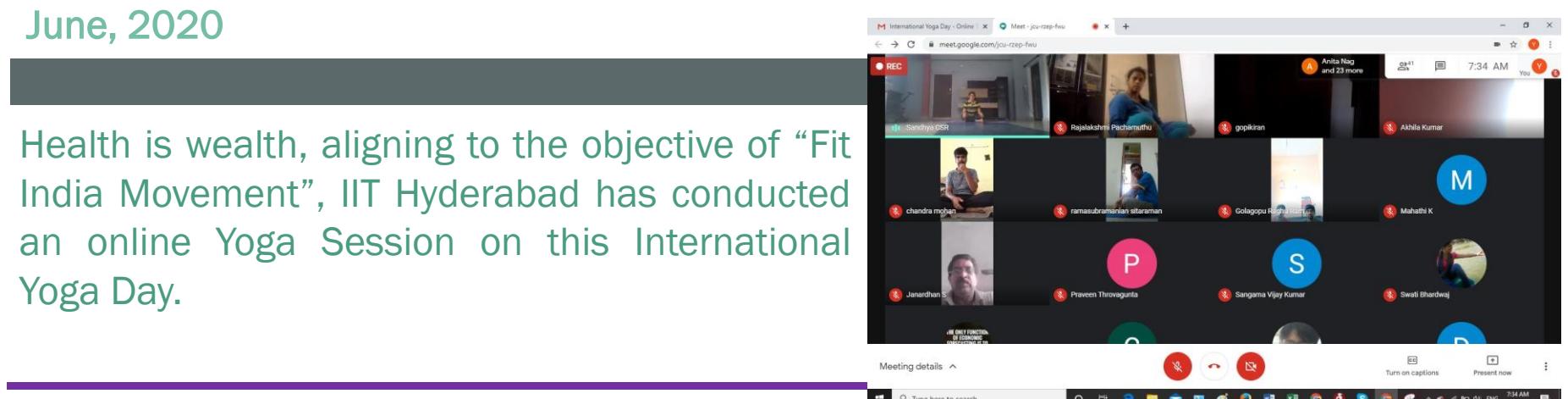


June, 2020

IIT Hyderabad researchers develop first of its kind #COVID-19 testing kit which can detect the #CoronavirusIndia within 20 minutes. The kit will be available at Rs. 350 once commercialized.

June, 2020

Health is wealth, aligning to the objective of “Fit India Movement”, IIT Hyderabad has conducted an online Yoga Session on this International Yoga Day.



IITH in the News

Media Coverage Snapshots of Last Quarter

IIT-H develops low-cost portable ventilator

PNS ■ HYDERABAD

Indian Institute of Technology Hyderabad Center for Healthcare Entrepreneurship (CfHE) incubated startup Aerobiosys Innovations has developed a low-cost, portable, emergency-use ventilator.

Called 'Jeevan Lite,' this device offers protection to healthcare providers as well as it is internet of things-enabled and can be operated through a phone app. It can also be battery-operated, enabling its deployment in areas without assured power supply.

The 'Minimal Viable Product' with the required functionality of this ventilator has already been developed. Pursuant to device certification, Aerobiosys



The device offers protection to healthcare providers as well as it is internet of things-enabled and can be operated through a phone application

Innovations aims to produce at least 50 to 70 units per day through collaboration with an Industrial Partner.

Reviewing the progress of this device, Prof. BS Murty, Director of IIT-H said, "Senior

citizens and elderly patients affected by Covid-19 will need ventilators for emergency life support. Aerobiosys has gone one step ahead by providing personal protection to the healthcare providers through IoT-

enabled monitoring."

Jeevan Lite can perform both the invasive and non-invasive ventilation across a comprehensive set of modes and settings. It can be used for pediatric and adult patients and

will work on rechargeable lithium-ion Batteries in an uninterrupted manner for five hours without power supply.

Speaking about this project, Prof. Remu John, Faculty Co-Head, Center for Healthcare Entrepreneurship, and Head, Department of Biomedical Engineering, IIT Hyderabad, said, "Jeevan Lite solution from Aerobiosys, unlike other low-cost models, is loaded with features including wireless connectivity and remote monitoring that makes it unique and equipped to meet the demands of a pandemic situation like the COVID-19 infection. I strongly urge the industry partners and the government to come up to hand hold the start-up

towards a large scale-up."

This would provide enough isolation to the patient and protection to healthcare providers and family members.

Aerobiosys Co-founders Rajesh Thangavel and Cyril Antony are confident that the design for manufacturing of their device can be delivered by first week of April 2020.

Cyril Antony said that Jeevan Lite had all the essential features to treat Covid-19 infected patients as mentioned by the experts in pulmonology and critical care across India and that the startup was collaborating with Hyderabad-based tertiary care hospitals for clinical validation and device certification.

People in Tier-1 cities better aware of pandemic'

IIT Hyderabad and IIT Bombay conduct joint study on the impact of COVID-19 on daily commuters

SPECIAL CORRESPONDENT
MUMBAI

A joint IIT Hyderabad and IIT Bombay study on the impact of COVID-19 on daily commuters during the transition phase between pre-lockdown and lockdown periods has indicated that people in Tier-1 cities were more aware of the pandemic.

The study, useful in understanding the decision-making behaviour of commuters while selecting their preferred mode of transport during a pandemic, required analyses of travel and visit behaviour changes that occurred during the third week of the outbreak in India.

The research team comprised Dr. Digvijay S. Pawar and Dr. Pritha Chatterjee, assistant professors, department



Wise decision: Passengers observe social distancing and wear masks during a bus ride from Dadar to Pune. ■ FILE PHOTO

ment of civil engineering, IIT Hyderabad; and Professor Nagendra Velaga, department of civil engineering, and Ankit Kumar Yadav, research student, IIT Bombay.

The data related to daily commute and visit behaviour was collected through an online questionnaire. Over 1,900 people participated in the study. The researchers received a majority of responses from Tier-1 cities (63.6%) followed by Tier-2

(20.6%) and Tier-3 cities (15.8%). Given the uncertainties in the minds of the commuters regarding their travel behaviour due to social distancing, it is important for policy makers and local transport authorities to understand the change in travel pattern," Dr. Pawar said, while emphasising on the importance of the study in shaping relevant policies related to COVID-19.

In Tier-1 cities, it was

GIt is important for policy makers and local transport authorities to understand the change in travel pattern

DR. DIGVIJAY S. PAWAR

IIT Hyderabad

found that around 12% of respondents switched from public to private modes of travel during the third week of COVID-19. This shift was about 9% in Tier-2 cities and around 7% in Tier-3 cities.

'Lockdown reduced risk'

The researchers said they believe that the lockdown declared by the government has decreased the risk of exposure to the coronavirus due to decrease in crowds in modes of public transport: buses, Metros and trains.

Nearly 48% of respondents said they did not travel to work during the third week of March, whereas 28% had the same frequency of travel to work. When enquired about cancellation of trips between cities using major mode of transportation, around 18% respondents said they cancelled their flights, while 20% cancelled train journeys. This indicates that the awareness of COVID-19 is higher in Tier-1 cities followed by Tier-2 and Tier-3 cities.

Elaborating on other studies being planned, Dr. Chatterjee said, "We are also trying to understand the effect of COVID-19 on transportation-related emissions. The data on reduction in vehicle miles travelled and vehicle type will be used to quantitatively model the reduction in traffic related emissions."

The researchers recommended spreading more awareness of the ill effects and spread of COVID-19, especially among the weaker sections of society. The rapidly changing nature of this pandemic is a threat to public health and making human life more challenging, the researchers said.

No need for MF investors to panic, says IIT-H study

TIMES NEWS NETWORK

Hyderabad: The mutual funds industry may be going through a volatile patch due to the coronavirus pandemic, but there is no need for investors to panic as long as the NAV (net asset value) of their MF investment does not fall drastically in the first quarter of the financial year 2020-21, a study on the performance of the Indian MF industry by the Indian Institute of Technology Hyderabad (IIT-H) said on Monday.

In the wake of the pandemic, volatility will continue to grip the MF industry because of investor concerns over the ongoing turmoil in the Indian economy, said the study by Prof Badri Narayan Rath, faculty, department of liberal arts, IIT-H.

The study pointed out that though the stimulus packages announced by the Union finan-

“ Investors with a continuous flow of income, who are aiming at long-term investment horizons, should not pull out their money from mutual funds irrespective of volatility in the equity and debt funds in the short term

Prof Badri Narayan Rath

ce ministry and Reserve Bank of India (RBI) may encourage MF investors to continue investing through SIP, it poses uncertainty about their future cash flows and exposure of investment to equity assets.

"Investors with a continuous flow of income, who are aiming at long-term investment horizons, should not pull out their money from mutual funds irrespective of volatility

in the equity and debt funds in the short term. Instead, small investors may shift from the Systematic Investment Plan (SIP) to Systematic Transfer Plan (STP) in the medium term to mitigate the risk amid the Covid-19 outbreak," Prof Rath said.

MFs have become the investment vehicle of choice for propelling wealth and widening the choice of India's middle class but the coronavirus-induced nationwide lockdown has wreaked havoc on the sector, the study said.

The research analysed the performance of equity and debt funds by considering the period between January 30 to March 15, 2020 as the Covid-19 low intensity phase and from March 16 to April 15 2020 as the COVID-19 high intensity phase to explore the linkage between Covid-19 and financial performance of the MF sector.

CfHE invites applications for fellowship programme

PNS ■ HYDERABAD

Indian Institute of Technology Hyderabad Centre for Healthcare Entrepreneurship (CfHE) has called for applications for the fifth batch of its fully-paid fellowship. The startups and Alumni of this Fellowship have developed solutions for major healthcare issues affecting India including Covid-19 pandemic besides infant mortality and other issues.

The programme is open to candidates with medical, engineering and design degrees. It offers a monthly stipend of Rs. 50,000 during first year of training. The number of Fellowships to be offered this year is 25. Housed in a 6,000 square feet, the CfHE incubator offers design and 3D fabrication facilities for prototyping of solutions and testing of medical devices and serves as a rapid acceleration platform for the fellows and startups.

Speaking about the unique aspects of the CfHE fellowship, director of IIT Hyderabad Prof BS Murty said, "A need was felt to usher in innovation and incubation culture in academic institutions. IIT Hyderabad has always been progressive to address such needs.

With a strong research in Biomedical Engineering, and lot of faculty from other departments engaged in interdisciplinary research in allied areas, it was only appropriate to identify healthcare as the theme for this endeavour."

This full-time in-residence fellowship and training will be strongly hands-on. The programme follows a carefully structured and comprehensive package of curriculum.

Two TS varsities figure in world 'Under 50 years old' rankings

IIT-H and UoH among four institutions from India in QS 2021 Rankings

R. RAVIKANTH REDDY
HYDERABAD

Only four institutions from the country found a place in the QS 2021 World University Rankings in the 'Under 50 years old' institutions category and two among them are from Telangana.

The rankings that were declared on Wednesday cover institutes established less than 50 years ago and still making a mark in the education sector. The top place in the country was bagged by the Indian Institute of Technology Guwahati (IITG) that figured in the 61-70 rankings band while it was at the 470th rank in the QS 2021 World University Rankings irrespective of its age.

The second position in the country went to Indian Institute of Technology Hyderabad (IITH) that was placed in the 101-150 rank range. The institute was in the 601-650 band rank in the combined ranking.

The University of Hyderabad (UoH), a central university, was also in the 101-150 band while it was in the 651-700 rank in the combined ranking. The O.P. Jindal Glo-



The second position in the country went to the Indian Institute of Technology, Hyderabad, which was placed in the 101-150 rank range. •FILE PHOTO

bal University also secured a place in the same band in the Under 50 category as well as the combined rankings. It is the only private institute to have got into the rankings.

Classified as a medium-sized public institution with high research intensity, the University of Hyderabad is the only multidisciplinary public university among the four institutions from India to figure in the list.

Academic reputation, employer reputation, citations per faculty, faculty-student ratio, international faculty and international students

are the parameters on which the university has been ranked by QS.

Singapore, bagged the top spot in the QS Top 50 Under 50, a table exclusively for the world's younger academic institutions.

Pak varsities fare better

Much to the surprise of Indian academics, three universities from Pakistan were placed at much better positions in the same rankings. The National University of Sciences and Technology (NUST) Islamabad secured 41st rank in the Under 50 category while it was at 355th rank in the combined ranking.

Similarly, Pakistan Institute of Engineering and Applied Sciences (PIEAS) was at the 46th rank while it secured 373rd rank in the combined list. The Lahore University of Management Sciences (LUMS) was in the 101-150 band in the 'Under 50' category.

QS World University Rankings is published annually by the British company Quacquarelli Symonds (QS). In the 2021 edition of the Rankings, 1,604 institutions from 93 locations were covered.

IITH start-up collaborates with Japanese firm

SPECIAL CORRESPONDENT

SANGAREDDY

The Indian Institute of Technology, Hyderabad (IITH) mentored start-up CRIOT Innovations has struck a research collaboration deal with Technocorpus, Tokyo, Japan.

CRIOT Innovations is working on building Dynamic Smart Home products that adapt to user behaviour. This collaboration is aimed to revolutionise the human authentication process using behaviour and lifestyle monitoring.

Dynamic Smart Homes operate by themselves with minimal human interaction, said Mr. Varun Perumalla, chief executive officer & co-founder, CRIOT.

IIT Hyderabad rises 5 positions in NIRF 2020

HARLEEN MINOCHA | DC
HYDERABAD, JUNE 11

IIT Hyderabad rose five ranks from last year to No. 17 in the overall category and ranked No. 8 in the engineering rankings 2020 according to the National Institute Ranking Framework (NIRF). The annual ranking was released by HRD minister Dr Ramesh Pokhriyal 'Nishank,' on Thursday.

Institutes are rated on parameters like teaching, research, graduation outcome, outreach, and inclusivity.

Speaking on the performance of the institute, Prof. B. S. Murty, director, IIT Hyderabad, said, "We always strive for excellence in academics, rese-

NALSAR UNIVERSITY of Law, Hyderabad, was among the three top law universities.

arch, and a better future for our students. The hard work by each member of IIT Hyderabad has paved the way to climb five points up in the overall NIRF-2020 rankings (from 22 to 17) and retained our engineering rank of 8 (and the best among the second and third generation IITs), and we will continue to deliver our best so that we can keep climbing this ladder."

The University of Hyderabad (UoH) was ranked as the sixth-best university in the country.

Responding to these rankings, Prof. Appa Rao Podile, vice-chancellor, said, "We are happy to have been ranked among the top universities in the country. We have to work hard as we have identified a few gaps to move up in the ranking system. UoH will increase its efforts to ensure that it is recognized as a top institution not only in India but also internationally for its quality of teaching, outreach, inclusivity, and research."

Nalsar University of Law, Hyderabad, was among the three top law universities along with the National Law School of India University, Bengaluru and the National Law University, New Delhi.

IITH in the News

Media Coverage Snapshots
specific to AI

Researchers at IIT-Hyderabad crack the code to AI models

KV KURMANATH

Hyderabad, September 10

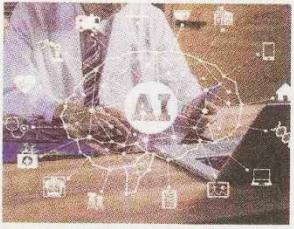
Artificial Intelligence (AI) models and programmes mimic the functioning of human brains, helping machines learn and make decisions. But how exactly do they arrive at such decisions?

In order to understand this, a group of researchers at the Indian Institute of Technology, Hyderabad (IIT-Hyderabad) have developed a method by which the inner workings of AI models can be understood in terms of causal attributes.

This finding assumes significance in the wake of regulations such as General Data Protection Regulation (GDPR) that requires organisations to explain the decisions made by machine learning methods.

Deep Learning

Modern Artificial Neural Networks, also called Deep Learning (DL), have become so complex that machines can train themselves to process data fed to them. They can almost



The team developed a method by which the inner workings of AI models can be understood through causal attributes

match human performance in many tasks. "Transparency and understandability of the workings of DL models are gaining importance as discussions around the ethics of Artificial Intelligence grows," said Vineeth N Balasubramanian, Associate Professor (Department of Computer Science and Engineering) at IIT-Hyderabad.

He worked on the project along with his students Aditya Chattopadhyay, Piyushi Manupriya, and Anirban Sarkar. Their work has recently been published in the Proceedings of 36th International Conference on Machine Learning.

ference on Machine Learning. "There are challenges to be met as the achievements in the field of AI and machine learning have wowed everyone," he said.

"A key bottleneck in accepting such Deep Learning models in real-life applications, especially risk-sensitive ones, is the interpretability problem," he said. "The DL models, because of their complexity and multiple layers, become virtual black boxes that cannot be deciphered easily. This makes troubleshooting difficult, if not impossible," said Balasubramanian.

The IIT-H team approached this problem with ANN architectures using causal inference with what is known in the field as a 'Structural Causal Model.'

"We proposed a new method to compute the Average Causal Effect of an input neuron on an output neuron. It is important to understand which input parameter is 'causally' responsible for a given output," he added.

Modern Artificial Neural Networks, also called Deep Learning (DL), have become so complex that machines can train themselves to process data fed to them. They can almost

IIT-H study can help machines explain decisions with AI help

TIMES NEWS NETWORK

Hyderabad: Machines can soon learn to make decisions in a more human-like manner as researchers at the Indian Institute of Technology, Hyderabad (IIT-H) have developed a method that can help machines explain their output using artificial intelligence (AI).

Complex machines can train themselves to process and learn from data that has been

supplied to them as input. However, how they arrive at decisions is unknown. The model, Artificial Neural Networks, helps machines explain why and how a conclusion was arrived at. "From predicting which movie to watch to occurrence of earthquake, our model will help machines explain the conclusions," said Vineeth N Balasubramanian, associate professor, department of computer science and engineering, IIT-H.

IIT-H finds way to bring more transparency to AI-based applications

EXPRESS NEWS SERVICE

@Hyderabad

WHEN it comes to applications involving the usage of Artificial Intelligence (AI), a lack of transparency in how decisions are arrived at is a major challenge, sometimes even raising ethical issues.

Now, researchers from the Indian Institute of Technology, Hyderabad (IIT-H) have developed a method to help resolve

this issue, paving way to implementation of applications in areas where an explanation is mandated by law (like the European Union General Data Protection Regulation), on how an AI-based system arrives at a certain decision. The practical implications of this research, whose findings were recently published in the Proceedings of 36th International Conference on Machine Learning, will help tackle the lack of transparency in AI on devices like phones, tablets and television sets. This could even end up preventing the end user's loss of trust in Artificial Intelligence systems.

It is important to understand which input parameter is 'causally' responsible for an AI system output. Our method provides a tool to analyze this – Dr Vineeth Balasubramanian, IIT-H

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It is important to understand which input parameter is 'causally' responsible for an AI system output. Our method provides a tool to analyze this – Dr Vineeth Balasubramanian, IIT-H



Where the problem arises
AI systems are based on Artificial Neural Networks (ANN), also known as Deep Learning (DL) models, which mimic the working of the human brain. These machines are designed to make decisions in a more human-like manner. In this process, machines can train them-

selves to process and learn from data supplied to them, and based on this, arrive at a decision.

However, how exactly they arrive at the decision is usually unknown, making them less useful in applications where the reasoning behind the decisions is necessary, like in the health domain.

Dr Vineeth Balasubramanian, associate professor at the

Computer Science department in IIT-H, said: "The DL models, because of their complexity and multiple layers, become virtual black boxes that cannot be deciphered easily. When a problem arises while running the algorithm, troubleshooting becomes difficult."

The IIT-H team resolved the issue of lack of transparency using a specially-devised model called the 'Structural Causal Model.'

IIT-H to access inner workings of AI programmes

Practical implications of this research are to tackle lack of transparency in Deep Learning models used in phones, tablets and television sets

HANS NEWS SERVICE

IIT-H researchers have developed a method by which the inner workings of Artificial Intelligence models can be understood in terms of causal attributes.

'Artificial Neural Networks' (ANN) are AI models and programmes that mimic the working of the human brain so that machines can learn to make decisions in a more human-like manner. Modern ANNs, often called Deep Learning (DL), have made tremendous progress in complexity and the ability to train themselves to process and learn from data that has been supplied to them as input, and almost match human performance in many tasks. However, how they arrive at decisions is unknown, making them less useful when the reason for decisions is necessary.

This work has been performed by Dr. Vineeth N. Balasubramanian, Associate Professor, Department of Computer Science and Engineering, IIT Hyderabad, and his students Aditya Chattopadhyay, Piyushi Manupriya, and Anirban



Sarkar. Their work has recently been published in the Proceedings of 36th International Conference on Machine Learning, considered worldwide to be one of the highest-rated conferences in the area of Artificial Intelligence and Machine Learning.

Speaking about this research, Dr. Vineeth N. Balasubramanian said, "The simplest applications

that we know of Deep Learning (DL) is in machine learning. It enables voice-based control in consumer devices such as phones, tablets, television sets and hands-free speakers. New algorithms are being used in a variety of disciplines including engineering, finance, artificial perception and control and simulation. Much as the achieve-

ments have wowed everyone, there are challenges to be met."

A key bottleneck in accepting such Deep Learning models in real-life applications, especially risk-sensitive ones, is the interpretability problem.

The DL models, because of their complexity and multiple layers, become virtual black boxes that cannot be deciphered easily. Thus,

when a problem arises in the running of the DL algorithm, troubleshooting becomes difficult, if not impossible," said Dr. Vineeth N. Balasubramanian.

The DL algorithms are trained on a limited amount of data that are most often different from real-world data. Furthermore, there are many correlations in data that must be corrected, which becomes hard.

"If treated as blackboxes, there is no way of knowing whether the model actually learned the right thing or not," said Dr. Vineeth N. Balasubramanian.

The practical implications of the lack of transparency in DL models are that end-users can lose trust over the system. There is thus a need to understand the inner workings of AI programs and unravel their structure and functions.

The IIT Hyderabad team approached this problem with ANN architectures using causal inference with what is known in the field as a 'Structural Causal Model.'

Explaining this area of work, Dr. Balasubra-

manian said, "Thanks to our students' efforts and hard work, we have proposed a new method to compute the Average Causal Effect of an input neuron on an output neuron. It is important to understand which input parameter is 'causally' responsible for a given output; for example in the field of medicine, how does one know which patient attribute was causally responsible for the heart attack? Our method provides a tool to analyze such causal effects."

Transparency and understandability of the workings of DL models are gaining importance as discussions around the ethics of Artificial Intelligence grow. Dr. Vineeth N. Balasubramanian's work on 'explainable machine learning' makes sense given the European Union General Data Protection Regulation (GDPR) regulation requires that in future, users must be provided if a machine learning model is used for any decisions made on its citizens, on any domain, be it banking, security or health.

The code developed by the IIT Hyderabad researchers to understand the workings of AI models, is available for free at <https://github.com/ICE/>. The research paper, it is also available publicly at <https://arxiv.org/abs/1902.02302> and <http://proceedings.mlr.press/v97/chattopadhyay19a.html>.

Speaking about the research, Dr. Vineeth N. Balasubramanian, associate professor, department of computer science and engineering, said, "The simplest application that we know of deep learning is in machine translation, speech recognition or face detection. New algorithms are being used in a

City IIT makes new inroads into AI tech

DC CORRESPONDENT
HYDERABAD, SEPT. 9

Researchers at the Indian Institute of Technology (IIT) Hyderabad have developed a method to tackle the lack of transparency in the deep learning (DL) models used in phones, tablets and television sets. The method, which accesses the "insides of artificial intelligence (AI) programs", will prevent end-users from losing trust over the system.

variety of disciplines, including engineering, finance, artificial perception and control and simulation. Much as the achievements have wowed everyone, there are still challenges to be met."

Dr. Balasubramanian felt there is a need for methods that can access the underbelly of AI programs and unravel their structure and functions.

The IIT Hyderabad team approached this problem with artificial neural network (ANN) architectures using causal inference with what is known in the field as a 'structural causal model.'

IIT-H researchers develop model to decipher AI work



CITY BUREAU
Hyderabad

Researchers from the Indian Institute of Technology, Hyderabad have developed a method by which the inner workings of Artificial Intelligence models can be understood in terms of causal attributes.

'Artificial Neural Networks' (ANN) are AI models and programmes that mimic the working of the human brain so that machines can learn to make decisions in a more human-like manner. Modern

ANNs, often also called Deep Learning (DL), have increased tremendously in complexity such that machines can train themselves to process and learn from data that has been supplied to them as input, and almost match human performance in many tasks. However, how they arrive at decisions is unknown, making them less useful when the reason for decisions is necessary.

An IIT Hyderabad team led by Dr. Vineeth N. Balasubramanian, Associate Professor, Department of

Computer Science and Engineering, and his students Aditya Chattopadhyay, Piyushi Manupriya, and Anirban Sarkar, approached this problem with ANN architectures using causal inference with what is known in the field as a 'Structural Causal Model.'

Explaining this area of work, Dr. Balasubra-

manian said, "Thanks to our students' efforts and hard work, we have proposed a new method to compute the Average Causal Effect of an input neuron on an output neuron. It is important to understand which input parameter is 'causally' responsible for a given output; for example in the field of medicine, how does one know which patient attribute was causally responsible for the heart attack? Our method provides a tool to analyze such causal effects."

The tool will help tackle lack of transparency in Deep Learning models, used in phones, tablets and television sets, and prevent end-users from losing trust over the system.

IIT-H to be the first Indian institute to launch BTech programme in AI

TIMES NEWS NETWORK

Hyderabad: The Indian Institute of Technology Hyderabad (IIT-H) is all set to launch a full-fledged BTech programme in artificial intelligence (AI) from the 2019-2020 academic session.

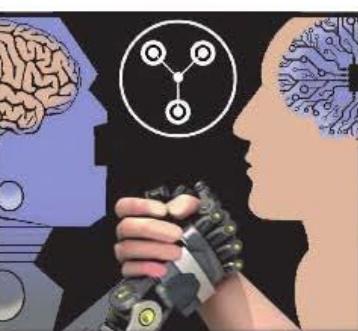
The institute claims to be the first Indian academic organisation to offer such a BTech programme in AI and in all probability, only the third institute globally, after Carnegie Mellon University and Massachusetts Institute of Technology (MIT), both in the USA.

According to a press release issued by IIT-H on Thursday, the course will have an intake of 20 students who will be selected through joint entrance examination (Advanced). The institute is already offering an MTech programme in artificial intelligence - machine learning.

On the thought behind launching the course, Prof

MAN AND THE MACHINE

- IIT-H's MTech in Data Science is for working professionals and comprises artificial intelligence and machine learning courses
- Students can complete the course in 2-5 years
- Department of Liberal Arts in collaboration with Computer Science and Electrical Engineering has launched a unique Minor in 'AI and Humanity'



- It looks into the influence of artificial intelligence on everyday lives and the society at large
- The Minor programme will make students think beyond the purely technical aspects of AI

ticals such as healthcare, agriculture, smart mobility among many others. Further, the ethical impact of AI and its technologies on privacy, bias and related issues will also be a key component of the programme.

Students pursuing other degrees such as BTech in chemical engineering or mechanical engineering can also pursue a minor in AI as well from the ensuing academic year.

Lauding the idea, Vineeth N Balasubramanian, associate professor, department of computer science and engineering, IIT-H, said, "we will provide training on various aspects of AI, ranging from technical ones like machine learning algorithms to ethical issues as well. After this, the industry will seek for our students. Their training will be comprehensive and well-rounded when working on AI-based technology solutions."



IIT-HYDERABAD TO INTRODUCE BTech IN AI

DC CORRESPONDENT
HYDERABAD, JAN. 17

IIT-Hyderabad will be introducing a full-time BTech programme in artificial intelligence in the 2019-20 academic year. Selections to the course, which has an intake of about 20 students, is through the JEE-Advanced.

IIT-Hyderabad is already offering an MTech course in artificial intelligence and machine Learning. At the under-graduate level, IIT-Hyderabad is reportedly the third institution to offer the BTech in AI in the world, after Carnegie Mellon University and Massachusetts Institute of Technology (MIT) in the US.

"The basic aim is to create a complete ecosystem for artificial intelligence academics and research," said IIT-H director Prof U.R. Desai. He said this included the BTech, MTech and minor programmes in AI. "Research and development would be strongly entwined with academics," Prof. Desai said.

With a view to providing a holistic view to students, the course would comprise algorithms from the computer science department, signal processing from electrical engineering, robotics from mechanical engineering and mathematical foundation. The course would also focus on healthcare, agriculture, smart mobility applications as well.

IIT-Hyderabad to build quality datasets

STATE BUREAU
Sangareddy

Indian Institute of Technology Hyderabad (IIT-H) is going to collaborate with the State government for research on AI. The Institute is partnering with the Information Technology, Electronics and Communication (ITE&C) Department for building/identifying quality datasets, along with third parties such as the industry. The IIT-H and Telangana

government will also work on education and training to prepare/deliver content and curriculum on AI courses to be delivered to college students and industry participants. The MoU was signed by Prof BS Murty, Director, IIT-H, and Jayesh Ranjan, Principal Secretary, IT.

Prof Murty said, "IIT Hyderabad is a pioneer in the field of AI. With a strong base of close to 25 faculty in the Department of AI, we are looking forward to such

opportunities to come up with many more innovations in the field."

Dr Vineeth N Balasubramanian, Head, Department of AI, IIT H, said, "This collaboration provides us an opportunity to leverage our combined experience in AI at IIT-H for social good. Having the Government as a partner will allow us an ideal interface to work with industry leaders, startups and colleges in research in Artificial intelligence."

'Way of life'

Artificial intelligence is an area that is becoming increasingly important in people's lives, said Dr Prasad VS Pannapalli, lecturer, Department of Engineering, Manchester Metropolitan University, UK. He interacted with B.Tech students and gave an overview of AI and Machine Learning (ML) during a seminar organised on AI at Gitam (deemed to be university) in Sangareddy district on Thursday.

IIT-H set to help TS govt carry out research on AI

DC CORRESPONDENT
HYDERABAD, JAN. 2

The Indian Institute of Technology Hyderabad (IIT-H) is going to collaborate with the Government of Telangana to carry out research in Artificial Intelligence. The Institute is partnering with the Information Technology, Electronics and Communication Department, for building, and identifying quality datasets, along with third parties such as Industry.

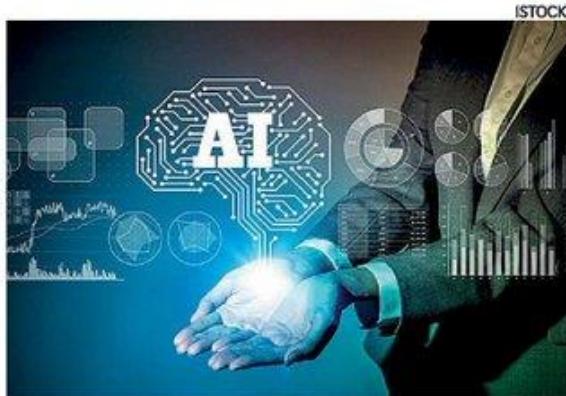
The Memorandum of Understanding (MoU) was signed by Prof B S Murty, director, IIT Hyderabad, and Jayesh Ranjan, principal secretary to Government of Telangana, during an event held on January 2, 2020 as part of 2020: Declaring Telangana's Year of AI initiative.

They will also work on Education and Training to prepare and deliver content and curriculum on AI courses, which are to be delivered to college students along with industry

participants. Prof Murty, director of IIT Hyderabad, said, "IIT Hyderabad is a pioneer in the field of Artificial Intelligence. IIT Hyderabad is the first institute in the country to launch a BTech program in AI. With a strong base of close to 25 faculty in the Department of AI, IIT Hyderabad is looking forward to such opportunities to come up with many more innovations and research achievements in the field."

Can BSc Data Sc take over vanilla BTech/BE

Rajlakshmi.Ghosh
@timesgroup.com



ITES firms continue to hire engineers due to lack of any other better option and invest substantially in training them to be data scientists and AI specialists," says Sundar Raj Vijayanagar, board member of Vijaybhoomi University.

"But over the years, the need for AI-skilled engineers even before the pandemic has become imperative, which is why a student majoring in civil engineering and pursuing a minor in AI will be more in demand than a vanilla civil engineer. This is due to the wide application of AI in all fields to ensure optimised use of scarce and expensive resources," Vijayanagar adds.

areas covered by AMOEBA: Artificial Intelligence,

Machine Learning, Optical Communications, E-commerce, Blockchain technology and Autonomous Vehicles. This is going to drive industrial growth with a rising demand for engineering education in these domains."

But then, even as AI, and data science continue to hold sway, there is a need to make each engineering stream industry-relevant, by infusing AI-related courses. "CSE, EE, AI and Data Science have been lucrative fields for the last few years (or decades), and this does not seem to

go away soon. Ultimately, if each engineering field trains students on contemporary technologies used in the industry and more sectors of the industry are opened up locally, hopefully, all engineering fields will have good prospects in terms of career growth and remuneration," says Vineeth N Balasubramanian, head, Department of Artificial Intelligence, IIT Hyderabad.

Way back in the 1980s,

BE/BTech degrees in India were gateways to live the American dream, fuelled by the growth of the IT and

ITES industry. However,

their demand started to plateau post 2008. "The IT and

With the heavy usage of Data Analytics and AI to build predictive models for corona patient and infection identification, data scientists will be in high demand in a post-covid world. While this might accelerate the demand for data science courses, the vanilla BE/BTech degrees would need a strong AI component with at least a minor specialisation to help solve real-world problems.

"Institutes must realise and embrace this change proactively and offer focussed courses on AI/ML at both UG and PG levels. There is also a need to carry out research in these fields in healthcare related topics and encourage entrepreneurship using AI/ML technologies," says Ranjan Bose, director, IIT Delhi. He adds further, "The world is evolving at a phenomenal rate, and so is the demand for new areas in engineering. In the post-covid world, we expect to see unprecedented growth in the

Production cost main hurdle for biofuel acceptance

IIT-H researchers study supply chain network of biofuels

SPECIAL CORRESPONDENT
SANGAREDDY

A model developed by researchers at the Indian Institute of Technology-Hyderabad (IITH), using computational methods like Machine Learning techniques to understand the factors and impediments to incorporating biofuels into the fuel sector in India, has found production cost to be the main hindrance to acceptance and use of biofuels.

The research, led by associate professor of the Department of Chemical Engineering Kishalay Mitra with his research scholar Kapil Gumte, has been spurred by the increasing need to replace fossil fuels by bio-derived fuels, which, in turn, is driven by the dwindling fossil fuel reserves all over the world, and pollution issues associated with the use of fossil fuels. The results of this work were recently published in the prestigious peer-reviewed *Journal of Cleaner Production*.

The model developed by the IIT-H team has shown that in the area of bioethanol integration into mainstream fuel use, the production cost is the highest (43%) followed by import (25%), transport (17%), infrastructure (15%) and inventory (0.43%) costs. The model has also shown



Kapil Gumte with prof. Kishalay Mitra • MOHD. ARIF

that feed availability to the tune of at least 40% of the capacity is needed to meet the projected demands.

A unique feature of this work is that the framework considers revenue generation not only as an outcome of sales of the biofuel but also in terms of carbon credits via greenhouse gas emission savings throughout the project lifecycle.

This research paper also won the 'Best Paper Award' during the Sixth International Conference on Advances in Control and Optimization of Dynamical Systems held at IIT Madras earlier this year. Highlighting the need for such research, Mr. Kishalay Mitra said: "We use Machine Learning techniques to understand the supply chain network. Machine learning is a branch of Artificial Intelligence in which, the computer learns patterns from available data and updates automatically to produce an understanding of the system and make forecasts of the future." "The analysis on country-wide multi-layered supply chain network and the use of Machine Learning techniques helped us capture the uncertainty in forecasting demands and other supply chain parameters and their effects on operational and design decisions," Mr. Mitra added.

intrude upon food sources."

Biofuel technologies are evolving in India. The design and implementation of technological, regulatory and policy approaches and pricing strategy of biofuels depend on a deep understanding of the supply chain network. Models such as those developed at IIT Hyderabad allow society to understand the effects of uncertainty in the network parameters on the demand-supply dynamics and can help policymakers devise and revise strategies to meet the future demands of biofuels, Mr. Mitra explained.

Elaborating on this research, Mr. Kapil Gumte said: "We use Machine Learning techniques to understand the supply chain network. Machine learning is a branch of Artificial Intelligence in which, the computer learns patterns from available data and updates automatically to produce an understanding of the system and make forecasts of the future." "The analysis on country-wide multi-layered supply chain network and the use of Machine Learning techniques helped us capture the uncertainty in forecasting demands and other supply chain parameters and their effects on operational and design decisions," Mr. Mitra added.

IIT HYDERABAD TO LAUNCH B-TECH IN ARTIFICIAL INTELLIGENCE

Hyderabad, Jan. 17: A full-fledged B-Tech programme in Artificial Intelligence would be introduced by the Indian Institute of Technology (IIT) Hyderabad, from the coming academic year.

Admission to the course with an intake of around 20 students

would be through the JEE-Advanced, a release said. IIT Hyderabad has become the first Indian Educational Institution to offer such a course in AI. The mission of the Department of Artificial Intelligence, IIT Hyderabad, is to produce students with a sound understanding of the

fundamentals of theory and practice of Artificial Intelligence and Machine Learning, it said.

IIT Hyderabad is already offering an M-Tech course in Artificial Intelligence Machine Learning. Director of the institute, UB Desai said, "The basic aim is to create a complete ecosystem for Artificial Intelligence Academics and Research at IIT Hyderabad." — PTI

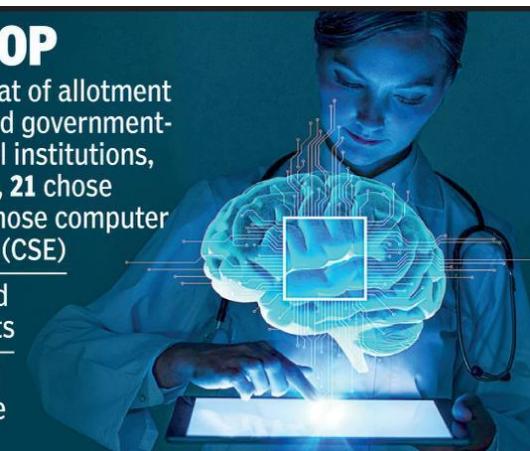
IIT-H ON TOP

► During the first seat of allotment for IITs, NITs, IIITs and government-funded technological institutions, of the 60 candidates, 21 chose BTech in AI and 39 chose computer science engineering (CSE)

► Hyderabad bagged most number of seats

► IIT-Indore secured one student from the top 1,000 club

► Not a single student from the top 1,000 opted for the other IITs — Bhubaneswar, Mandi, Patna, Jodhpur, Gandhinagar, Ropar, Tirupati, Jammu and Dharwad



(Numbers according to the Joint Seat Allocation Authority)

Happy Alliances

IITH & NVIDIA Collaboration on AI

IIT Hyderabad and NVIDIA Establish Joint AI Research Centre in India

Housed at IIT Hyderabad, the NVAITC will focus on fundamental AI algorithms, as well as building solutions in the fields of Agriculture, Smart Cities, and Language Understanding



**Mr. Vishal Dhupar,
Managing Director
NVIDIA South Asia**

“NVIDIA is powering the AI revolution across research facilities everywhere. Our collaboration with IIT Hyderabad will accelerate AI research and help create innovative solutions to real-world challenges.”

The NVAITC represents another step in NVIDIA’s collaborations within the state of Telangana. The State Government recently announced 2020 as the ‘Year of AI’ with an aim to establish Hyderabad among the top 25 global AI innovation hubs. NVIDIA is already a partner to the government of Telangana in this endeavor.

Alumnus Diary

What ahead???
(A synopsis of IITH Alumni's Life)



Aditya Srinivas Timmaraju

1. Tell us a little about yourself?

I am Aditya, a Software Engineer at Facebook in the Ads Core ML team. I graduated from IIT Hyderabad in 2013 with a major in Electrical Engineering and a minor in Computer Science, having done projects on audio and video information retrieval. After that, I pursued my MS from Stanford University in Electrical Engineering, with a focus on Computer Vision and Natural Language Processing. At Facebook, I work on multi-modal content understanding and stochastic neural networks for combinatorial optimization. In my free time, I enjoy hiking, playing tennis, board games, solving crosswords and reading.

2. What made you join IIT, Hyderabad?

At the outset, I'll refer interested readers to a post on my blog in which I spoke about this (<https://tadityasrinivas.wordpress.com/2013/06/26/jee-counselling/>). To put it succinctly, I wanted to pursue a four-year degree in Electrical Engineering which I felt at the time would give me broad exposure to different disciplines within engineering, allowing me to later specialize in one among a range of different fields. I also remember having visited IITH before counselling to learn about research being pursued at the time. And it helped that I was born and bred in Hyderabad all my life!

3. Which subject did you enjoy most and Least & Why?

I'd pick four – Math behind Machine Learning, Speech Signal Processing, Image & Video Processing, Information Theory. These classes equipped me with strong fundamentals and intuition that I find useful to this day in my work. An unconventional addition I'll make to this list is “Intro to World Literature”, which I chose as one of my Liberal Arts electives. It was just one of many such avenues that IITH gave me to explore my full breadth of interests.

4. Which other activities were you involved in?

I was quite active in the student community in various spheres viz., cultural, technical and literary domains. On the literary side, I was one of the Coordinators in Elan in 2011-12 and was also the elected Literary Secretary in Student Gymkhana 2011-12. I edited the student magazine Reverb, besides organizing a host of Quizzes and Spell Bees. To fuel my technical passions, I cofounded the Electronics Club with Aniket, besides having been active in Cepheid (the astronomy club) and the Sci-tech Council. What started as a random jamming session one night in the Music Room ended up creating a full-fledged band. Our band performed and won awards at Grand Musical Nites and other such events at IITH.

Continued...

5. What specialized training have you had?

Having been at Stanford during the shift towards deep learning, I consider myself fortunate to have had experience in both classical ML algorithms as well as deep learning. I also worked on robotics for a summer at Qualcomm Research, giving me exposure to another interesting avenue that learning is being increasingly applied to. Now, I work primarily on (1) multi-modal understanding of content on web-scale platforms such as those at Facebook, (2) applying recent advances in stochastic neural networks to approximately solve intractable combinatorial optimization problems.

6. How have your education and training prepared you for your current job role?

The classes I mentioned earlier as my favorite courses laid foundational knowledge viz., teaching me the underpinnings of graphical models (HMMs, GMMs), SVD, PCA and other domain specific knowledge like audio and image/video related features. Besides these, there were three classes in particular at Stanford that I owe other facets of my current ML knowledge to – Convex Optimization, CNNs for Visual Recognition, Deep Learning for NLP. All of the above courses at IITH and Stanford imbued me with the fundamentals I find useful in my day-to-day work even today. They help me approach problems from a first-principles perspective.

7. The best moment you can recall from yours' life @ IIT Hyderabad?

It's incredibly hard to pick one, but a few that are right up there – 1) Election results counting night when I contested for Literary Secretary 2011-12, which was equal parts fun and exciting, 2) Performing the timeless graduation song “Papa Kehtey Hai” and the Linkin Park hit “Bleed It Out” at the farewell ceremony we organized for our seniors’ batch, 3) Receiving the Gold medal for excellence in academics and extracurricular activities from NR Narayana Murthy, 4) Pulling (almost) an all-nighter to prepare live demos for a couple of projects – a Shazam like music retrieval app, and a phone recording based video search app. It felt amazing when the live demos worked flawlessly the following morning.

8. What message do you want to convey to the existing student folk @ IIT, Hyderabad?

This may sound like a trope but is as good a message as I can give an IIT student – work hard and play hard, you will look back at these years as some of the best in your life. Minimize spending time cocooned watching shows/movies on your laptop (not to say don't do this at all), but go out there and explore your interests deeper, be it music, sports, arts or whatever else excites you! Pursue technical projects that channel your passions into creating something unique.

9. What as per you is best about IITH and please suggest an improvement area for betterment?

I love that we are a young and nimble institute, which has enabled us to move fast when it comes to fractional credit courses, introducing new programs at the BTech level to name a few. I am indebted to the bright faculty that have inculcated in me, both technical knowledge as well as a sense of discipline. At IITH, there are a variety of avenues available to students to chart out their unique trajectories based on skills and interests. As for an area of betterment, perhaps finding a way to get temporary exchange students from other countries, if logistically possible, to add to the diversity of exposures to our students.

10. What is the best way to contact you?

The best way to reach me is at my email address - tadityasrinivas@gmail.com

11. Any other message you want to communicate!

I'd be remiss if I didn't mention https://mitadmissions.org/blogs/entry/50_things/, current students should check this out.



Aniket Anand Deshmukh

1. Tell us a little about yourself?

I am working as a Data and Applied Scientist at Microsoft AI and Research in Sunnyvale, California. My broader research interests span a variety of areas in statistical and reinforcement learning applied to various applications in text and image. I have published papers in contextual bandits, deep learning and transfer learning at venues like NeurIPS, JMLR and ECCV. I completed my MS-PhD focused on machine learning in 2019 from the University of Michigan, Ann Arbor, and bachelor's degree in electrical engineering from IIT Hyderabad. You can find more details about my machine learning research work at <https://aniketde.github.io/>. Apart from machine learning I love to spend time outdoors and like hiking and camping!

2. What made you join IIT, Hyderabad?

I am from the second (2009-2013) B Tech batch of IIT Hyderabad. The main reason to join IIT Hyderabad was the city of Hyderabad's information technology ecosystem.

Continued...

3. Which subject did you enjoy most and Least & Why?

There are some defining subjects that I can clearly point out. Prof. Balasubramaniam Jayaram taught us a part of real analysis in the first semester. Thinking about the definition of limits, continuity in terms of epsilons and deltas was very hard at the start. But Prof. Balasubramaniam made the course so enjoyable. I still remember thinking about “True and False” questions in the exam which cleared many concepts during the exam! Prof. Balasubramaniam’s courses and teaching has had a huge impact on my machine learning career. Speech signal processing course taught by Prof. K Sri Rama Murty was also one of the turning points in my career where I started focusing more on signals and data. I still remember how we could identify the waveforms of phonemes during the speech signal processing course. I can write more details about Prof. Sumohana’s image processing course and Prof. Soumya Jana’s Information Theory course but to be brief - both professors and their courses have impacted my research career more than anyone else!

4. Which other activities were you involved in?

As one of the pioneering batches, we had a lot of opportunities to start new initiatives. In 2010-2011, along with my roommate Sharan B. (who is pursuing his PhD in astrophysics), we started Cepheid, the astronomy club of IIT Hyderabad. In 2011-2012, along with Aditya Srinivas (works on AI and ML too), we started Elektronica, the electronics club of IIT Hyderabad. I was a science and technology secretary in 2011-2012 and started the tech festival which is called Nvision today. Life at IIT Hyderabad was busy and happening! There were so many extra-curricular opportunities that I had to manage my time well between academics and other activities.

5. What specialized training have you had?

My focus is broadly on machine learning with limited labelled data. I love formulating and modelling machine learning problems at hand, coming up with new algorithms and implementing them to solve a practical problem. During the initial phase of my machine learning career, I focused more on theoretical problems but in the last three-four years, I have also been looking at more practical problems using deep learning.

6. How have your education and training prepared you for your current job role?

I was hired at my current job role because of my expertise in machine learning and reinforcement learning. Strong foundation in mathematics, signals and data from IIT Hyderabad and then focus on machine learning with limited labelled data during Ph.D at the University of Michigan prepared me well for my current job role.

Continued...

7. The best moment you can recall from yours' life @ IIT Hyderabad?

Best moments at IIT Hyderabad are almost always with my fellow batchmates and friends. We used to play “Age of Empires 2” game all night at the hostel, go for night walks in the campus, debate philosophy and astronomy and travel to Zam Zam Dhaba to eat spicy food! Friendships formed during the four years at IIT Hyderabad are still running strong! Because of shelter-in-place (covid-19), we started playing “Age of Empires 2” again which has rekindled so many cheerful memories of life at IIT Hyderabad!

8. What message do you want to convey to the existing student folk @ IIT, Hyderabad?

I had written a long post when I graduated from IIT Hyderabad in 2013 - “To all my IITH juniors - <https://daniket1992.wordpress.com/2013/07/23/to-all-my-iith-juniors/>” I still think all these points are relevant.

Briefly- Explore, try new things, work hard, maintain good academic standing, and have fun! IITH alumni are doing really well across the world. Don’t worry about your future but have fun and work hard in the present.

9. What as per you is best about IITH and please suggest an improvement area for betterment?

IITH is a pioneer in academic innovation. IITH was the first one to start a fractal academic system, artificial intelligence focused degree and one of the first to start a double major system in India. IITH should continue to give more academic flexibility to students!

10. What is the best way to contact you?

Email – daniket1992@gmail.com, Web - <https://aniketde.github.io/>



Bharat Bhusan Sau

1. Tell us a little about yourself?

Masters in Computer Science, 2016 pass out.

Senior Software Engineer in Mobiliya Technology, Bangalore.

Role: R&D in AI/DL.

We build great solutions for AI projects, as well as try to make significant progress in AI/DL research fields.

Continued...

2. What made you join IIT, Hyderabad?

Computer Science department in IITH became renowned in a few years only. I wanted to work under Dr. Vineeth Balasubramanian even before I joined there. I was lucky to get a chance to work under him and learn many important lessons during my thesis.

3. Which subject did you enjoy most and Least & Why?

Most: Randomized Algorithm(Taken by Subruk Sir)- It forced me to think so deeply and calmly to understand the varieties of algos. I enjoyed it just like playing chess!!

Least: Linear Optimization(Sobhan Sir)- Becoz I didn't attend many classes(I was overburdened with other heavy courses), which I regret, I was clueless one week before the viva. Many others were in bad-shape like me, however, I could manage getting A-(8/10), after sleeplessly working on it for 7 days. Also, I remember that prof told us to attend all the classes if we wanted to pass, yet we ignored his advice!!

4. Which other activities were you involved in?

Cycling, playing cricket.

5. What specialized training have you had?

Using Deep Learning for computer vision tasks. I explored 'Deep Model Compression' and arxived a paper, which has gathered 69 citations to date.

6. How have your education and training prepared you for your current job role?

Today, I am working as an R&D engineer in the field of AI/DL because the courses I took, helped me to learn so many things which is difficult to learn while doing a job. Mindset and approach of good computer engineer can be built in IIT only.

7. The best moment you can recall from yours' life @ IIT Hyderabad?

Studying whole night in Kandi Lab and return by walking with friend in early morning.

8. What message do you want to convey to the existing student folk @ IIT, Hyderabad?

Enjoy your stay at IITH, you will cherish this whole in your life.

But have a single-minded focus on your goal, and work tirelessly, work hard and enjoy hard. Take a thesis in the area of your interest only and make an impact on it before you pass out. Join jobs which are mostly in your area of interest, don't look only for high package job.

Continued...

9. What as per you is best about IITH and please suggest an improvement area for betterment?

Best: I liked scolding of my guide :).

Improvements needed (maybe):

Academics: Many students take the courses lightly, the competition was not fierce among the students. The best result comes when the competition for the grade is fierce, and some of the below-performing students get F grade. Fear of getting F grade needs to be there among the students, else many will keep enjoying only. Although, plz don't make it as strict as IITK.

Non-academics: No cycling group during my time, lack of badminton court, need a restaurant inside the campus(like CCD/ biriyani house), swimming pool (very important for regular exercise and refreshment).

10. What is the best way to contact you?

Whatsapp: 9051193548, email: sau.bharatbhusan@gmail.com.

11. Any other message you want to communicate!

It feels good to share old memories, thanks for communicating us.



Neelesh Dewangan

1. Tell us a little about yourself?

I was part of the batch 2014-2016 and completed my Masters degree in Computer Science and Engineering from IIT Hyderabad. After graduation, I moved to Tokyo, Japan and am currently working as a Machine Learning Engineer at SmartNews.

2. What made you join IIT, Hyderabad?

IIT Hyderabad was one of the best colleges to get a degree in Computer Science and its reputation for 100% placement was one of the factors that made me join there.

Continued...

3. Which subject did you enjoy most and Least & Why?

I used to enjoy Algorithms and Machine Learning and doing assignments related to it. Least favorite subject was Computer Network.

4. Which other activities were you involved in?

Mostly TA works for Data structure and algorithms and also for DBMS subjects.

5. What specialized training have you had?

During coursework, I mostly focused on Machine learning related subjects and did my thesis in Data Mining which later turned out to be Journal (with the help of a friend). We proposed a novel approach to explore commercial product reviews with the related features based on user interest and feature ontology.

6. How have your education and training prepared you for your current job role?

Since my thesis and most of the course work is aligned with the current role, it provided a good foundation and it's being used in my day to day life.

7. The best moment you can recall from yours' life @ IIT Hyderabad?

Starting and finishing the whole project overnight just before the final submission. Also, birthday parties where all the friends get together and have a lot of fun.

8. What message do you want to convey to the existing student folk @ IIT, Hyderabad?

Not much. Just focus on the present and work hard. It will pay off in the future.

9. What as per you is best about IITH and please suggest an improvement area for betterment?

I think IITH is already doing much better in terms of industry exposure for students and providing relevant coursework. Keep improving collaboration with industries as well as universities that will give more opportunities for the students.

10. What is the best way to contact you?

LinkedIn: <https://www.linkedin.com/in/neeleshdewangan/>

11. Any other message you want to communicate!

Enjoy every bit of college life!!



Sneha Reddy Kudugunta

1. Tell us a little about yourself?

I received my bachelor's degree in Computer Science and Engineering in 2018. Since then, I've been at Google Research working on AI problems related to transfer, multilinguality, and massive neural networks.

2. What made you join IIT-Hyderabad?

I knew I wanted to be a researcher - I visited the campus to talk to faculty and students and came away thinking this would be a good place to work on interesting things.

3. Which subject did you enjoy most and least, and why?

Most: I enjoyed all my CS labs and creative arts courses because of all the hands-on work.
Least: Any class before 9 AM.

4. Which other activities were you involved in?

I spent a lot of time at Litsoc, mainly as Editor-in-Chief of the IITH Lexicon (our literary e-magazine). I also dabbled in several things, such as being a Student Mentor with Sunshine, quizzing, working on the programming club team, and playing Basketball.

5. How have your education and training prepared you for your current job role?

Apart from developing my research skills by doing research with Dr Vineeth Balasubramanian and doing some research internships, I use what I learnt in my systems and advanced ML regularly. In addition, a large part of my job is writing papers and paper reviews, which use the skills I honed while working on the IITH Lexicon.

6. The best moment you can recall from yours' life @ IIT Hyderabad?

Rather than any specific moment, it was the little moments with my friends: gossiping at the mess, going on long walks, and having a blast on trips.

7. What message do you want to convey to the existing student folk @ IIT, Hyderabad?

Spend a lot of time doing things that interest you: it will never be as easy to explore as many different interests as at college, both inside and outside of academics.

Continued...

8. What as per you is best about IITH and please suggest an improvement area for betterment?

One thing I liked about IITH was how much freedom we had choosing advanced courses later on and how easy it was to get involved in research. I think one thing I'd like to see is more alumni in my area of work, which will only come with time.

9. Any other message you want to communicate!

Don't forget to have a lot of fun!



Tanya Marwah

1. Tell us a little about yourself?

I am currently a PhD student in the Machine Learning Department at Carnegie Mellon University. My current research lies at the intersection of Machine Learning and Statistics and I am currently working on Generative Models.

Before this, I received my Masters' in Robotics from the Robotics Institute at Carnegie Mellon University while my undergraduate degree was in Electrical Engineering from IIT-Hyderabad.

2. What made you join IIT, Hyderabad?

The fact that it was doing really well among newer IITs and also close to a city like Hyderabad.

3. Which subject did you enjoy most and Least & Why?

I believe most of the classes I took at IITH have helped me in one way or another. Whether it was the core EE and CSE courses or a five-day course on movies and drama, I thoroughly enjoyed them all.

If I were to pick one particular course that I enjoyed the most, it would be Dr. K Sri Rama Murty's course on Pattern Recognition and Machine Learning. It was my first formal introduction to Machine Learning and sparked in me a joy that propelled me to pursue a career in research.

Continued...

4. Which other activities were you involved in?

I participated in a few Basketball Leagues (I hope they still take place) and volunteered in the cultural and technical festivals (Elan and Nvision). However, to be completely honest, our dearest professors in the Electrical Engineering Department ensured that we were inundated with enough things to do, that my “other” activities were limited to just that.

5. How have your education and training prepared you for your current job role?

I feel that the most important skill for a PhD is perseverance. I think that my time as an undergrad working with Dr. Vineeth N. Balasubramanian, and my time as a Masters student at CMU definitely prepared me for just that.

6. The best moment you can recall from yours’ life @ IIT Hyderabad?

Long walks at night with friends first in the ODF campus and then in the main Campus were beautiful moments that make some of my fondest memories.

7. What message do you want to convey to the existing student folk @ IIT, Hyderabad?

The work that you put in these 4 years is going to help you throughout your life (but you already know that). I would also encourage people to experiment more and try to be audacious when setting your life goals.

8. What as per you is best about IITH and please suggest an improvement area for betterment?

Being a new institute, IITH did not shy away from embracing change and tried to actively keep up with all the advancements in technology. This is evident from the unique academic curriculum and emphasis on research. Further, IITH provides a supportive environment, in terms of peers as well as faculty. I have gained lifelong friends and mentors from my time at IITH.

9. What is the best way to contact you?

My contact information is available on my website. The best way is to email me.

IITH's Bank of Knowledge

New Members in the IITH family
(Arranged in the order of individual's date of joining)



June, 2020

Commodore Manohar Nambiar has taken over as Registrar, IIT Hyderabad w.e.f. 01 June 2020. He has served in the Indian Navy in various capacities, both afloat and ashore for more than 34 years. A specialist in Anti-Submarine Warfare, he has participated in Op Pawan in Sri Lanka (1987-88) as well as the Post Tsunami operations in Galle, Sri Lanka in Dec 2004/Jan 2005. A qualified Interviewing Officer from Defence Institute of Psychological Research, Delhi; he was the President of the Naval Selection Board at Coimbatore for three years. He holds an MSc in Defence and Strategic Studies from the Madras University and a Ph.D in Management from Osmania University. He has served in the faculty at College of Defence Management Secunderabad for Six years, teaching Operations Research, Project Management and Research Methodology. His research interests include International relations with particular reference to China as well as Job/Occupational analysis in Human Resources Management

Both Cmde & Mrs Nambiar practice Yoga and other forms of physical fitness on a regular basis.

Life at IITH: My transition from the Indian Navy over the last three months has been a smooth sail, thanks to the understanding superiors and supportive colleagues at IITH, notwithstanding the constraints imposed by the COVID-19 pandemic. It is indeed a proud privilege and honour for me to be a part of the IIT Hyderabad Fraternity and to contribute to the growth and development of this prestigious institution.

Dr. Avinash Eranki has joined Dept. of Biomedical Engineering as Assistant Professor. Graduated with a Ph.D from Utrecht University, and a M. S. from George Mason University in Electrical Engineering. Dr. Eranki has worked at the National Institutes of Health, Bethesda, Maryland for over a decade. He has also been a R&D Staff Engineer at Children's National Medical Center, Washington, DC, and the Department of Radiology and Imaging Sciences at National Institutes of Health, for 6 years, where he worked on developing newer Image-guided Therapeutic Ultrasound Techniques to treat cancer. He was also a key part of the team that was the first to treat children suffering with solid tumors with MRI-guided HIFU.



Life at IITH: Experience at IITH has been great, with vibrant faculty and students. I look forward to a productive research and teaching career, leading to impactful outcomes that benefit the society.

June, 2020



June, 2020

Dr. Mohammad Shahid has joined Dept. of Design as **Assistant Professor**. Dr. Mohammad Shahid has a diverse design background with a Bachelor of Design (B.Des) in Textile Design from National Institute of Fashion Technology (NIFT), Master of Design (M.Des) and PhD in Design, both from Department of Design, IIT Guwahati with core specialisation in Visual Communication/Graphic Design. His PhD thesis under Dr. D Udaya Kumar is based on "Understanding the visual vocabulary of the title design and its role in Bollywood movie posters."

Prior to joining Department of Design, IIT Hyderabad, he was working as an Assistant Professor at MIT Institute of Design Pune. His area of interest is typography, design research, visual branding and identity design. He has designed identity for the National Institutional Ranking Framework (NIRF) for the Ministry of Human Resource Development, Government of India. He believes that design education is not just confined to a classroom, but it is like an old tradition where one learns by becoming part of the surrounding environment inspired from nature and assisted by the individual imagination.

Life at IITH: I am really honored to be part of IITH Family. We shifted to IIT Hyderabad campus in the month of June, in COVID-19 pandemic time with lots of fear and doubts in our mind. However, support from faculty and staffs helped us to overcome the anxiety. Now, we have a mini garden with more than 150 plants on 16th floor of faculty tower and enjoying our stay in the campus...😊

Dr. Oves Badami has joined Dept. of Electrical Engineering as Assistant Professor. Bachelors from University of Mumbai, Dr. Oves did M.Tech from Indian Institute of Technology Bombay in Electrical Engineering dept. (Microelectronic specialization). After gaining some experience at SRDC IBM India Pvt Ltd, he pursued PhD from University of Udine, Italy.

He won Best Paper Award for his research contribution to ESSDERC 2015. After his Ph.D in March 2018, he moved to the University of Glasgow as Postdoctoral Research Associate where he worked until March 2020.

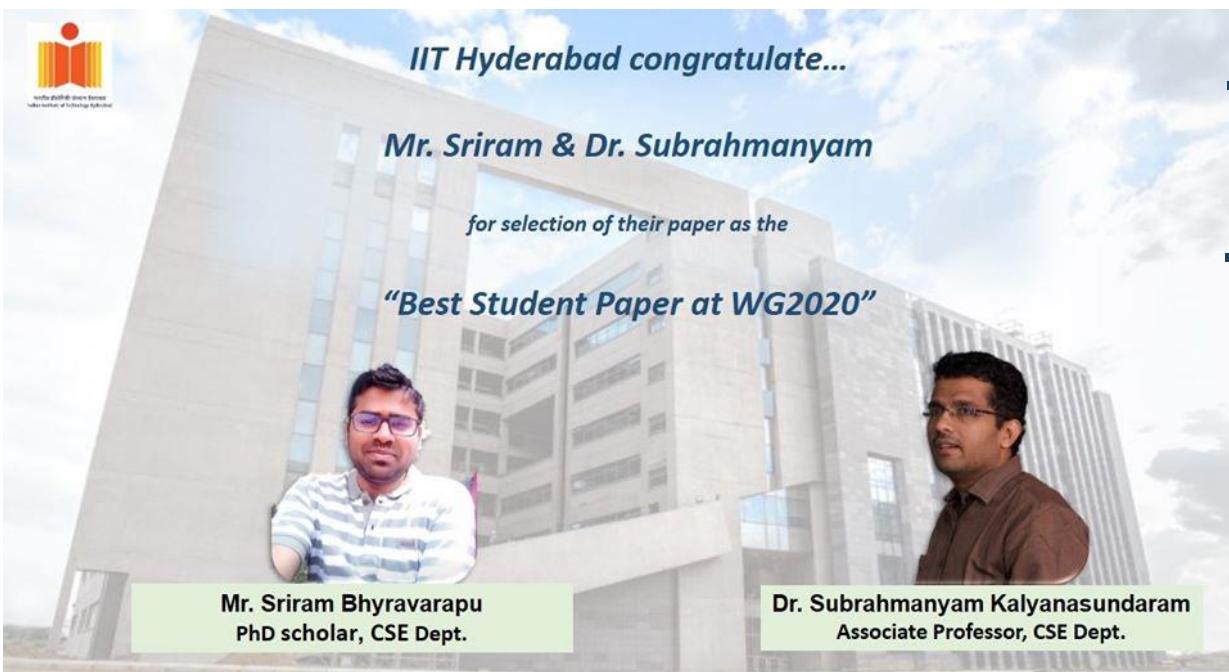
Life at IITH: I am having a very good time at IIT Hyderabad. I have received all the help and support from my colleagues and other IITH family members which has smoothed out the transition especially in the current difficult times (arising due to COVID-19).



June, 2020

Moments of Pride

Rewards & Recognition of Q2 2020



Dr. Subrahmanyam & Mr. Sriram
Dept. of Computer Science Engg.

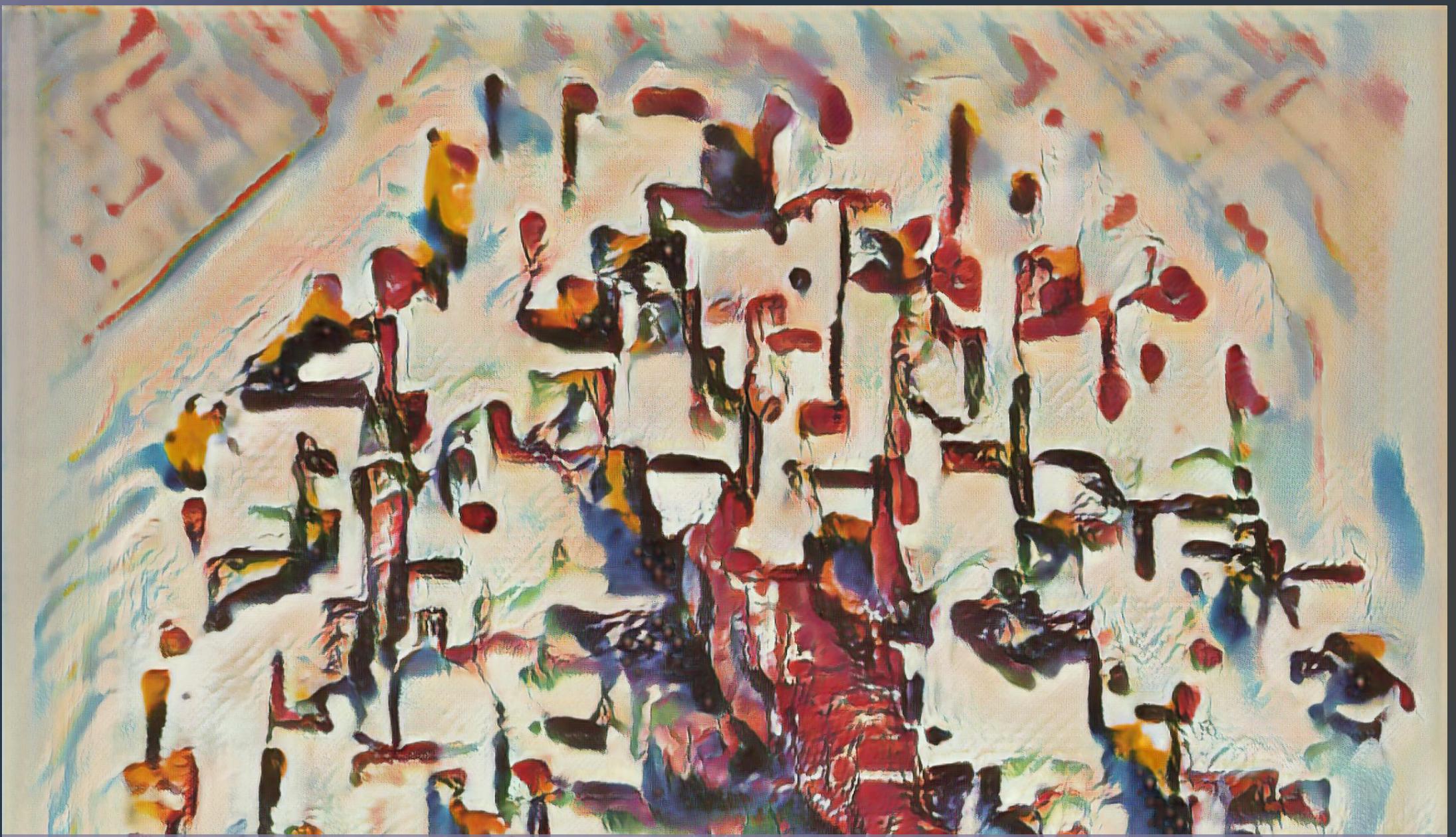


Mr. Sohail Faizan Shaikh
M.Tech Alumnus, Dept. of Biomedical Engg.



Ms. Sreya Majumdar
Ph.D Candidate, Dept. of Liberal Arts





Featured Image:

Mandala using AI: This artwork is made by Mathew, Department of Design using Artificial Intelligence by Joseph Jayadev Tsukka under the guidance of Prof. Deepak John.

This computer-generated art uses techniques from traditional procedural programming and deep learning. There are two deep learning models used in this artwork, one model generates photorealistic output from given semantics and the other uses style transfer - a process of adding style to an image while preserving the content. In this image, the semantics of fruit and flower are mapped as circles and rectangles which are rotated in series to form a mandala pattern on the background which is mapped with the semantic - table. After the semantics are laid out, the photorealistic output is generated which is then fed into the style transfer model trained on the style of the artist, Wassily Kandinsky.

Please send
your suggestions to:

Design Courtesy: DOD-IITH

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