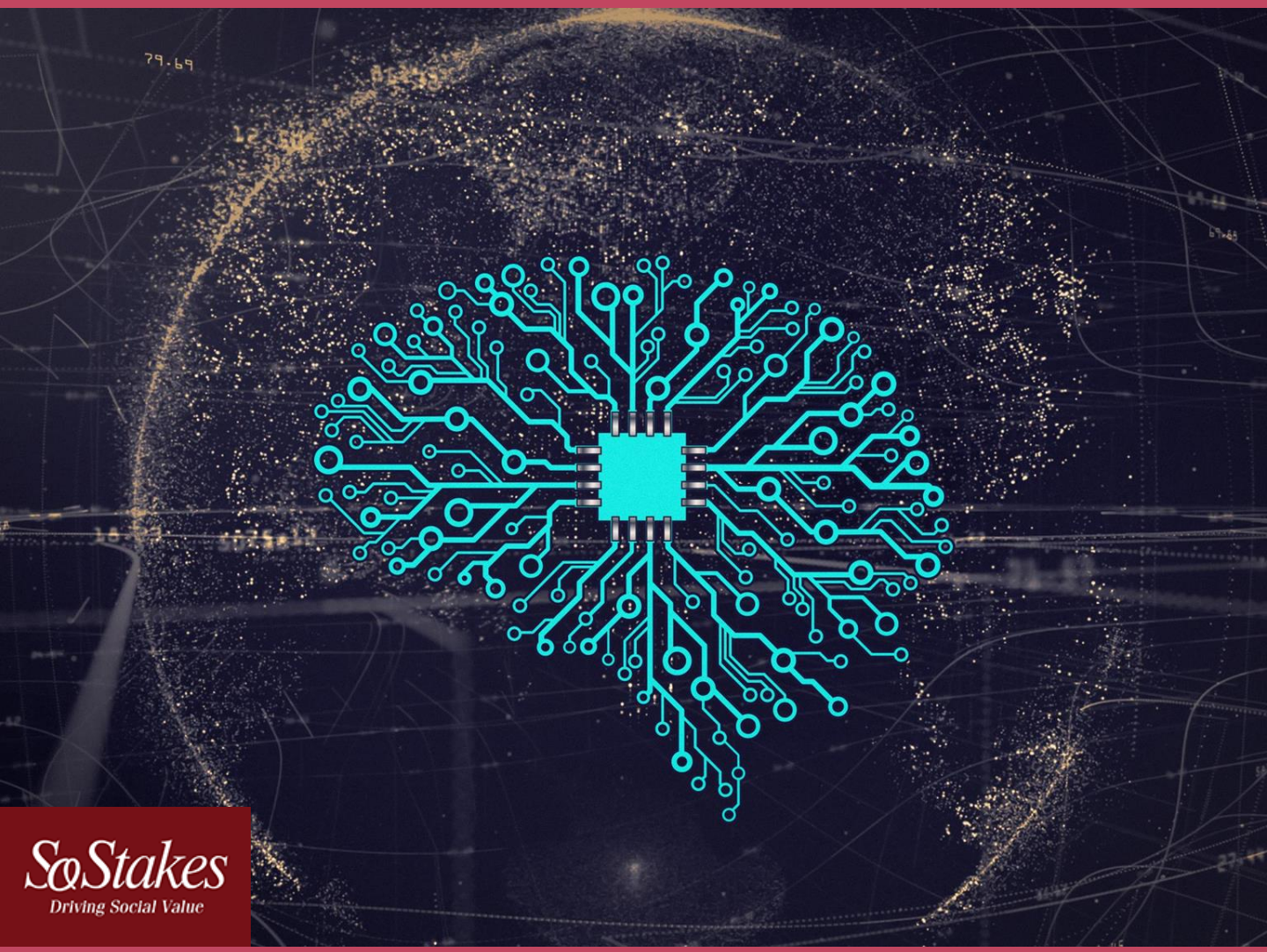
Mphasis - IIIT Bangalore
Centre of Excellence for Cognitive Computing
2018–21

Impact Assessment Report



SoStakes
Driving Social Value

SoStakes Services Private Limited
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Executive Summary

Mphasis partnered with the International/Indian Institute of Information Technology, Bangalore (IIIT-B) in September 2018 to set up the Mphasis – IIIT-B Centre of Excellence (CoE) for Cognitive Computing as part of their Corporate Social Responsibility (CSR). This initiative aligns with Mphasis' aim of using technology-based innovations to create social impact. The CoE has initiated research projects that leverage cognitive computing technology to find solutions in areas of education, accessibility, healthcare, and enterprise. Mphasis has supported CoE with a total grant of ₹5.78 crores for 2018 - 2021.

The CoE has initiated 12 research projects in the past three years. Some projects were undertaken in collaboration with NGOs to help develop various solutions.
In 2018, research projects undertaken were –

- Indian Sign Language Synthesis for converting English text to animated ISL videos that end-users can access from an avatar. Friends for Inclusion (an NGO) has used it to make the Sign IT app (an ISL signer application).
- Navigated Learning for learning and tracking progress using competency maps. Gooru (an NGO) used it for developing its Navigator application to improve pedagogy and learning outcomes for learners and instructors.

In 2020, as a response to the COVID-19 crisis, the CoE supported two projects –

- BelYo – a blockchain platform for digitising and sharing individual COVID-19 information for COVID-19 care. The startup has since expanded the platform to manage a wide range of healthcare data and it set to deploy it in Kenya for the Red Cross Society.
- Clinical Decision Support System – a platform for sharing credible COVID-19 protocols for screening and diagnosis. The platform was effectively used in IIIT-B's eHealth Centre's Jidhaan project by frontline health workers for diagnosis and care for COVID-19 in villages in Jharkhand.

In 2021, the CoE team initiated 7 projects related to healthcare, governance, education, and enterprise.

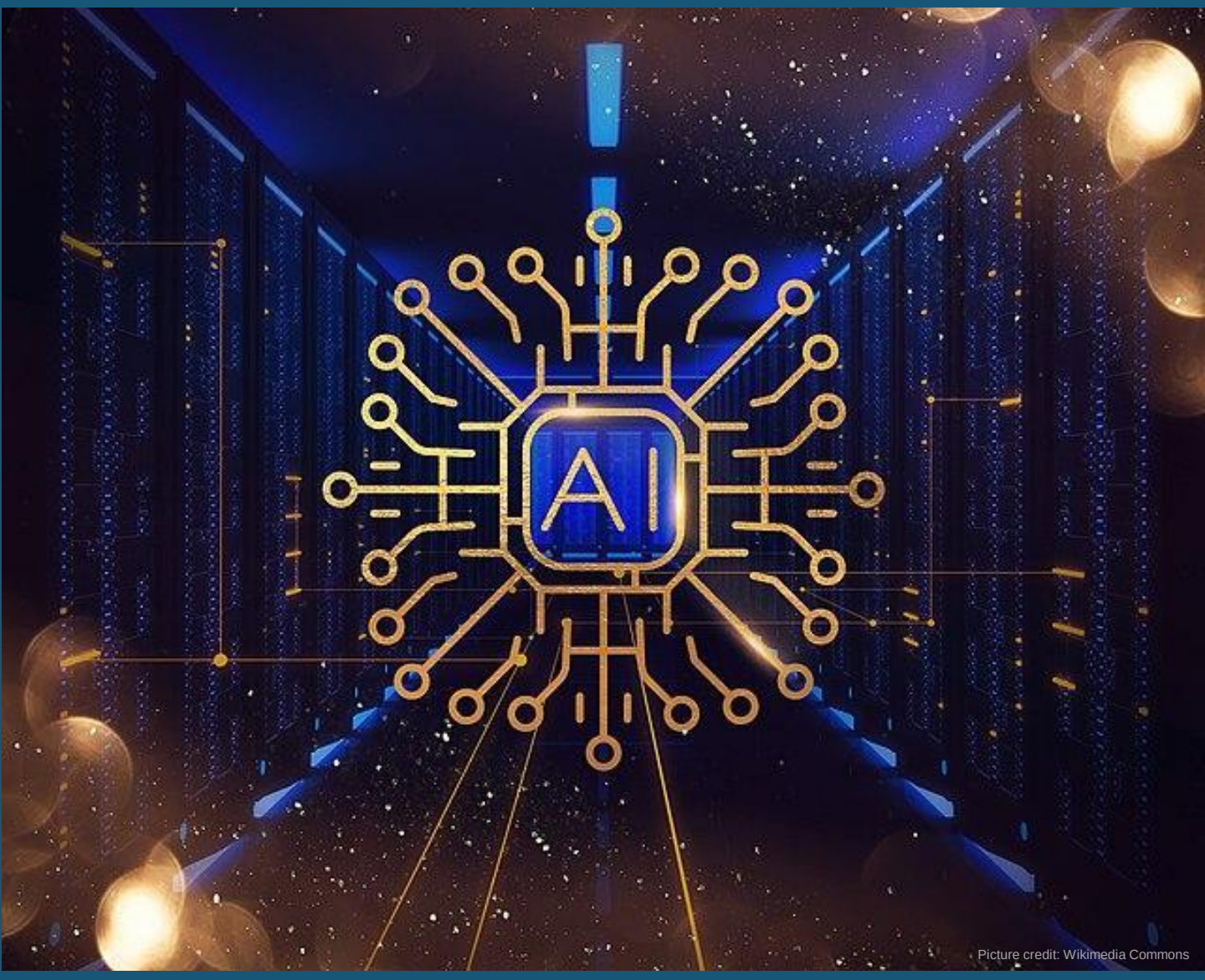
Of the 12 research projects, 3 projects have been completed, 6 projects have successfully developed the proof of concepts/prototypes, and 3 projects are in the early stages of development. The CoE has also conducted workshops and talk series' to enable dialogue and exchange of ideas amongst the various research projects and stakeholders.

This impact assessment is being conducted to capture the progress and contributions made by the Centre's activities during the years of its operation. In addition, the assessment will provide Mphasis with critical feedback and recommendations for the project. We have relied on qualitative data obtained via in-depth telephonic interviews with key stakeholders, including research project teams, the Joint Management Committee, and the NGOs and startups collaborating with the CoE's research team. The OECD framework, covering the aspects of Relevance, Effectiveness, Efficiency, and Impact, has been used for the assessment.

Key Takeaways and Recommendations:

The assessment has highlighted areas related to programme design, monitoring, application, and review process that could be strengthened in the future –

- Research projects initiated in 2021 (GWDF, Data Processing, CT Scan Analysis, Medical Images Segmentation) have broad areas of applicability. While this is a long-term vision, a narrower focus may strengthen use case possibilities.
- A periodic review of projects has to be undertaken to provide timely feedback and direction to the research projects.
- The research projects have shared solution codes on GitHub. Tracking engagement on GitHub and a more targeted approach for knowledge-sharing could improve research applicability in the future.



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Chapter 1
Introduction

Introduction

1.1 Context

AI (Artificial Intelligence) and ML (Machine Learning) have seen numerous and distinctive successes across several sectors like entertainment, manufacturing, social media, consumer goods, and healthcare – for e.g., self-driving cars, VR game simulations, and on online streaming platforms. These commercial applications have indirect positive social impacts, such as the increasing availability of information to the broader public through better search and language-translation tools and more efficient transportation. Seeing the success of AI in the commercial sector, a call has arisen to replicate the success in the social sector to impart direct positive social impact.

"AI (Artificial Intelligence) for Social Good" is a concept generating traction over the past five years. Since AI has paved the way for several technological breakthroughs, the idea that it could be used to create practical, scalable models for social good has also arisen. AI potentially holds the key to solving various problems in health, education, livelihoods, and more. In terms of the holistic impact of AI, a study by Nature in 2020 estimated that AI could help achieve 79% of the Sustainable Development Goals.

However, AI and ML training and research come with their fair share of challenges. Since it is an emergent field in developing countries, there is a lack of qualified trainers. Further, AI training requires high-functioning tech equipment and physical spaces to house the equipment and conduct the training. The challenges with AI and MI research arise when implementing existing algorithms and models to work well for a new application.

In India, the need of the hour is to foster an ecosystem at the intersection of artificial intelligence learning and social work. While NGOs in India use technology for their interventions, the usage of AI-powered tech remains low. Such technology is not available widely, nor do NGOs possess the technical skills to apply it in their development programs. Thus, the wider requirement is to not just create AI-facilitated interventions, but also to train social workers on the field to utilise the tech effectively and efficiently. Further, since AI is constantly evolving, it would need the research to be regularly updated and tested on the field with minimal delays.

1.2 Corporate Social Responsibility of Mphasis Ltd.

Mphasis Ltd. carries out its Corporate Social Responsibility through its F1 Foundation (established in 1998). Mphasis' CSR approach is based on their belief that technology can play a transformational role in areas of education, livelihood creation and equitable development. In line with this belief, Mphasis' CSR is focused on developing innovative solutions in the social space and driving excellence.

1.3 Centre of Excellence (CoE) for Cognitive Computing

In September 2018, Mphasis (Mphasis F1 Foundation) collaborated with IIIT Bangalore to establish the Centre of Excellence (CoE) for Cognitive Computing in IIIT-B campus. Mphasis F1 Foundation has supported CoE with a grant of ₹5.78 crores with an aim to support research for social impact.

The Centre aims to enable engagement in research in cognitive computing and its subdomains to find solutions in the space of education, enterprise and accessibility, with a focus on persons with disabilities. In 2021, healthcare and governance were added to its research areas. The Centre also shares its intellectual property assets/codes in their open source platform – GitHub in order to build a community of knowledge sharing. CoE's activities are:

i. Research projects in computational cognition
ii. Workshops and talk series'.

The CoE is headed by a Joint Management Committee consisting of the Dean of IIIT-B (R&D), and the Head of Research and Innovation, Mphasis Ltd. The research teams include faculty and PhD students.

1.4 CoE's Focus Areas

Accessibility
- Indian Sign Language Synthesis

Education
- Navigated Learning
- Generalised Wasserstein Deep Forest
- Deep Generative Model
- Remotely Accessible Lab

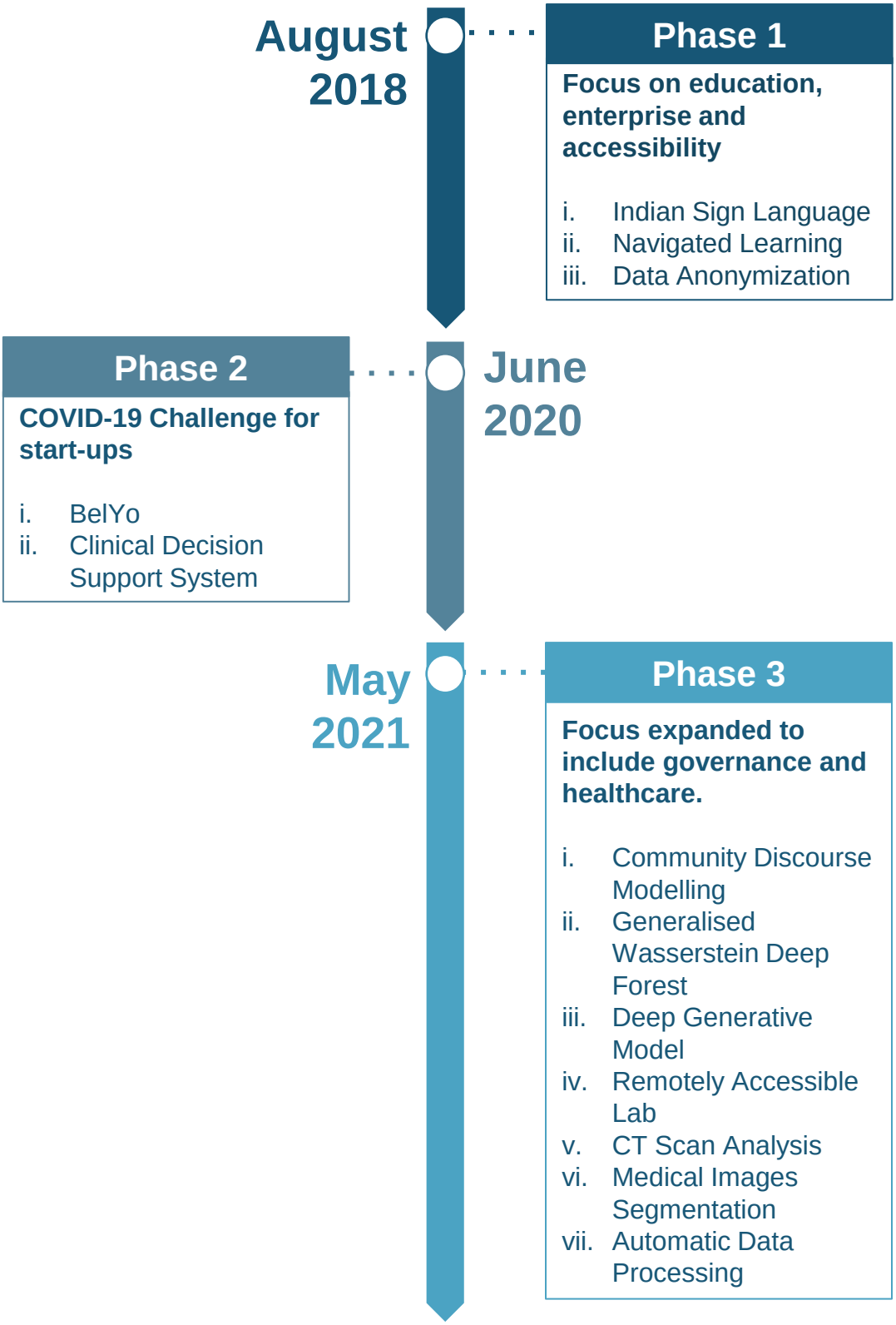
COVID-19
- BelYo
- Clinical Decision Support System
- CT Scan Analysis

Enterprise
- Data Anonymization
- Automatic Data Processing

Governance
- Community Discourse Modelling

Healthcare
- Medical Images Segmentation

1.5 Programme Timeline (2018–21)



Picture credit: Wikimedia Commons

Chapter 2
Programme Activities

Research Projects

2.1 Phase 1

The CoE started by organising a symposium on 27th September, 2018 with IIIT-B and representatives from the social sector.to discuss challenges, strategy and solutions. Thereafter, 3 research projects were initiated in September 2018 in the areas of accessibility, education, and enterprise.

1. Indian Sign Language Synthesis

Develop algorithms to automate and provide real time synthesis of Indian Sign Language (ISL)

Project duration: August 2018 **–** 2023 *(estimated)*

People with hearing impairment in India are at a disadvantage as they do not have access to most existing education and media content in English. The project seeks to bridge this gap by creating a system to automatically translate English content to ISL, which can be related to users via an animated avatar/human form. Through the project, the team has initiated and expanded current research on ISL synthesis.

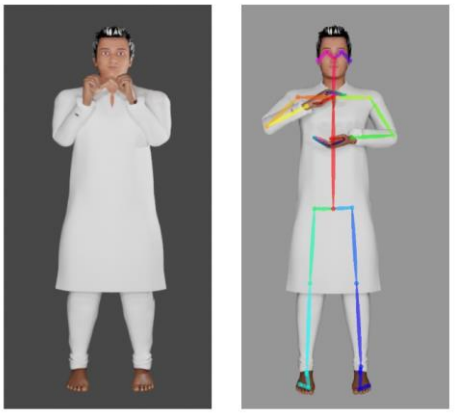


Image 1: Video to Avatar

The system involves rule-based English to ISL gloss Machine Translation framework followed by an animation module using hand-crafted animations playing the output sequentially. Gesture animations were created using graphic designers (animation for 1300 words completed). Multiple sign videos (motion videos by human signers) were mapped to an avatar as an image level transfer. The team is working on automating animations, and using Generative Adversarial Networks (GANs) based transfer of multiple signer videos to one human model video, which will give a human touch to the application.

Current Status:

- Proof of Concept – Gesture animation for 1300 words have been completed, and mapping to avatar prototype completed. The code and demo has been shared on GitHub.
- The system has been used by NGO Friends for Inclusion to create an ISL signer application named Sign IT.
- 2 papers presented at international conferences.

Next Steps:

- The team is working on expanding the gesture animation vocabulary from 1300 words to 5000 words.
- Conversion of sign videos to avatar videos is currently under process and is expected to be completed in a year. GAN based transfer will take about 2 years to get completed.

2. Navigated Learning

Develop learning maps automatically from a corpus of learning resources to improve pedagogic process and learning outcomes.

Project duration: August 2018 **–** 2024 *(estimated)*

Distance/online learning has challenges for both students and teachers such as limited opportunities for engagement and interactions for students, restricted time settings, and teachers and students are unable to actively track learning progress. Learning maps provide representation of learning spaces in navigable 2D forms where learners can view their learning space, understand where they are within that space, and track individual progress.

IIIT-B collaborated with Gooru Labs, an education-based platform in 2018 to work on a solution based on learning maps.

The team is working to automatically generate a 2D learning map from a given corpus of learning resources. The project uses competency maps, and mapping polylines onto the 2D space using Multi-Dimensional Scaling. The learning maps can then be used in implementing learning pathways, and personalisation of learning routes.

Image 2: Screenshot from Gooru website of mobile application

Current Status:

- Proof of Concept – Competency maps, web portal and trailer generation codes have been created and shared on GitHub.
- The competency maps have been used by Gooru Labs to create the Gooru Navigators.
- 3 papers published – The team has presented at 2 international conference and published 1 paper in an international journal.

Next Steps:

- The team will evaluate competency map generation for different sets of learning resources, while considering ideas on scalability, language and access barriers.
- The team will continue working on Application Programming Interface (API) integration with dashboard and automatic trailer generation. The project is expected to be completed 2024.
- The competency maps can be used by other organisations working in the learning space to create learning applications.

3. Data Anonymization

Project duration: August 2018 **–** 2019 *(completed)*

Data anonymization is a widely used data processing technique for protecting sensitive or personally identifiable information from a database. While data anonymization tools exist, the team has worked to create a web application that allows data anonymization along with the option to configure the extent of anonymization. For this, the team collaborated with Justice and Care, an NGO working to rescue and rehabilitate victims of human trafficking.

The project aims to develop an application to effectively track, use, and analyse sensitive information (online data footprint of traffickers such as FIRs lodged, details of suspected traffickers and victims) using data anonymization. The tool is a general- purpose tool which can be used with any given dataset in various settings, such as hospitals, to anonymize patient data, etc.

Current Status:

- Proof of Concept – The tool development process has been completed. The code has been shared on GitHub.
- The application has not been utilised by Justice and Care yet due to absence of dedicated IT personnel at their office. However, IIIT-B research team has shared that they will explore possibilities of using of the tool in the Centre for Internet of Ethical Things (CIET) working on privacy frameworks, set up by Government of Karnataka.

2.2 Phase 2

In an effort to respond to the first wave of COVID-19 crisis, Mphasis and CoE set up a COVID challenge in June 2020 inviting proposals from startups that had been nurtured by the CoE. 2 projects – BelYo and Clinical Decision Support System (CDSS) – were selected for Mphasis' grant support:

1. BelYo

Convert COVID-19 clinical and vaccination data in physical form into digital formats to enable safe access to third parties for verification.

Project duration: June 2020 – December 2021 *(completed)*

BelfricsBT and YoSync startups received Mphasis grant support to develop BelYo – a blockchain-based platform to convert COVID-19 clinical and vaccination data of citizens from physical form to digital assets, which could be accessed by third party contact tracing apps like Aarogya Setu via application programme interface (API). The team planned to license the platform to government hospitals, testing centres, and others who could use it to verify citizen's COVID-19 and vaccination status.

Current Status:

- Proof of Concept – The platform development was completed by December 2021. The platform code has been shared on Github.
- BelYo was a contender in the national hackathon for integration with Aarogya Setu/COWIN but did not qualify. However, Belfrics and YoSync have been making efforts to expand the platform for management of a wider set of healthcare data.

2. Clinical Decision Support System (CDSS)

To help frontline health workers access protocols for COVID-19 management.

Project duration: June 2020 – December 2021 *(completed)*

The project was selected to address the the need to provide healthcare professionals and caregivers with latest credible information on COVID-19.

The team worked to create CDSS tools to enable a centrally managed system with latest COVID-19 information and guidelines that would help frontline health workers to screen cases, and take decisions regarding COVID-19 testing, quarantine, and/or hospital admission.

CDSS was developed collaboratively by IIIT-B's EHealth Research Centre, HealtheLife, and Digital Health India Association. The tool's design allows for easy integration with external applications.

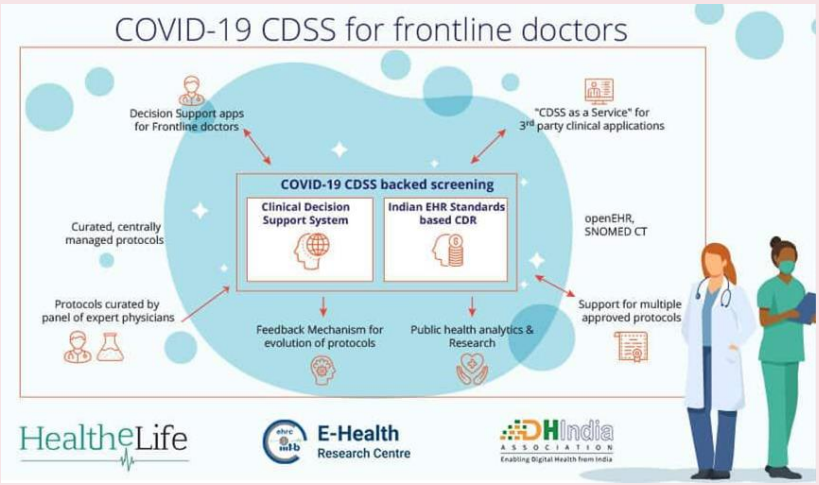


Image 3: CDSS overview

Current Status:

- Proof of Concept – The development of CDSS was completed by Aug-September 2020. The APIs have been made available on GitHub for developers working on similar healthcare applications.

Use Case:

The system was successfully used in IIIT-B's eHealth Centre's Jidhaan project by NGOs (PHIA, PRADAN and Transform Rural India (TRI) working on the ground in Jharkhand with support from Azim Premji Philanthropic Initiatives (APPI).

The research team believes that model can be replicated to address various healthcare challenges.

2.3 Phase 3

The third phase research projects initiated in 2021 have expanded the focus areas to include healthcare, technology for landcover and agriculture research. These projects are in various stages of completion.

1. Community Discourse Modelling

Develop technology to convert Kannada speech to text using semantic processing models.

Project duration: May 2021 – December 2024 *(estimated)*

The project was initiated in collaboration with Janastu, an NGO that has set up a community-owned WiFi mesh (COWmesh) radio network for around 15-20 villages in Devarayandurga, Tumakuru district as part of its ICT intervention for local communities. This radio network promotes local communication that is accessible via radio booths across villages. Janastu, over the years, has built a communication database (audio recordings) mainly in local Kannada language, that can be used to highlight community concerns and influence policy decisions.

Image 4: School children's visit to Janastu for Discourse Modelling exercise.

The IIIT-B project team is leveraging the A14Bharat initiative of IIT Madras that has developed Natural Language Processing (NLP) concepts in Indic languages, including Kannada. The team is working to improve upon speech into text conversion for Kannada, and to apply AI and NLP in their attempt to develop community discourse models. Janastu's communication data corpus will be used to identify themes, topics, and concerns of the community.

Current Status:

- The team is working on audio-to-text conversion. They are trying to deal with the challenge of using models trained in literary language to convert speech that is colloquial and replete with local slangs. Existing AI models for converting speech to text are available, but most use formal and literary language.

Next Steps:

- The team will work on semantic processing models, topic modeling, argument mining, and sentiment analysis – texts will be segmented and divided into different sentences and words to identify names, parts of speech, etc.
- The text will be built into a knowledge graph with storylines, narratives and opinions from the community which can be then be analysed.

2. Generalised Wasserstein Deep Forest

Design interpretable, scalable deep models that can operate imbalanced datasets.

Project duration: August 2021 – May 2024 *(estimated)*

The project aims to address the class imbalance problem in deep learning methods by developing a new deep model - Wasserstein Deep Forest (GWDF). This is an imbalanced learning algorithm designed specifically for imbalanced datasets and can be applied in a wide range of domains with minority class problems. The team is considering application of the solution in image recognition tools in banking sector, medical imaging and land cover recognition tools.

The team has worked on near optimal neural tree (NONT) model, and will incorporate Wasserstein function. The model will solve three problems under imbalanced learning- tabular learning, multi class imbalance classification (to be used in medical field, face recognition at airports, etc.); and imbalance learning of the dataset shift (based on testing and training data to see the changes over the years - e.g. data of cancer patients, based on their characteristics, recovery rate).

Current Status:

- Prototype: The framework and mathematical formulation of the GWDF model is ready. The code for tabular learning was put up on GitHub in January 2022.
- The team is currently working on experimentation of GWDF model standard imbalanced datasets.

Next Steps:

- The team will work to extend and incorporate Wasserstein function.

3. Deep Generative Model

Develop innovative methods which utilise trained deep generative models for Earth science applications.

Project duration: June 2021 – December 2024 *(estimated)*

Geo-spatial data is used for research in many areas like urban planning, agriculture, climate change, natural disaster management, etc. The project is working to improve the learning capability of machine learning algorithms for the minority classes using deep generative model framework. This is to improve the classification performance of highly imbalanced geospatial dataset for Earth Science applications. The project addresses the problems of imbalance data classification, dynamical systems, domain adaptation, and adversarial attacks on Earth Science applications.

Current Status:

- Prototype – The team is experimenting with classifier on available datasets (satellite images), and analysing data.
- The project team has submitted its the first paper in ACM SIGKDD International Conference in January 2022.

Next Steps:

- The team will experiment the classifier on expanded real world datasets and different domains. The domain adaptation will be completed by September 2022. The team will then work on dynamical systems and Generative Adversarial Network.

4. Remotely Accessible Lab

Build a remotely accessible lab for students to perform experiments on engineering concepts.

Project duration: August 2021 – 2023 *(estimated)*

Remotely accessible labs allow usage of hardware for experiments over the internet and have been developed globally to aid students of engineering disciplines. The IIIT-B research team is working to develop a similar remote lab in India which, unlike current simulation-based systems, will provide access to hardware. This will allow students of Mechanical/Electrical/Data Science engineering to perform experiments in real-time remotely from anywhere. Students will also get an opportunity to use hardware which is expensive, and not usually available in many universities.

Image 5: DC motor hardware used by lab

Experiments can be conducted on industry-grade DC motor experimental set-up which can be activated through a website using LabVIEW software. The team will also test-bench Reinforcement Learning and other AI/Machine Learning methods, such as neural networks.

Current Status:

- Proof of concept – Traditional control approaches of speed control of a DC motor has been tested successfully. 8-10 experiments have been conducted. The team is currently working to create manuals for conducting experiments, and also programming neural network implementation to replace the model.

Next Steps:

- Copies of the hardware system will be created to enable use by multiple parties.
- The team will also explore ways of running the lab and regulating its usage.
- The remote lab technology can be potentially used for teaching courses in platforms such as Coursera, and National Programme on Technology Enhanced Learning (NPTEL) system. NPTEL is hosted by IITMadras, which provides e-learning through online web and video courses.

5. CT Scan Analysis

Project duration: July 2021 – June 2022 *(estimated)*

Develop a model which does real-time analysis of CT scan.

This project was in response to the need for quicker and more reliable COVID-19 detection methods as RT-PCR tests take several hours. The IIIT-B project team has proposed automatic real-time analysis of CT scans to detect COVID-19 infection and contour of lesions. This can effectively assist in detection and classification of pulmonary disorders and reduce human error in diagnostics.

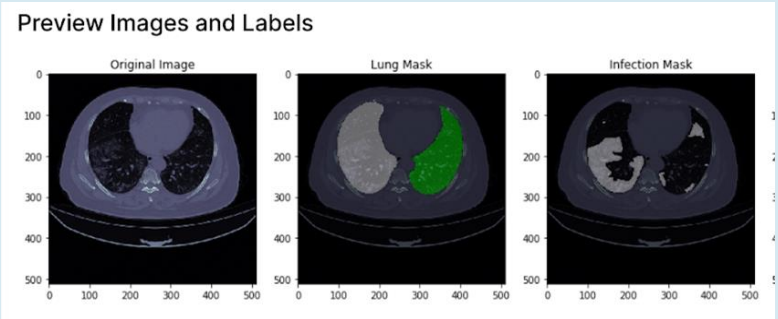


Image 6: CT Scan sample data

The team is developing a data processing module based on deep learning multi tasking framework for simultaneous classification and segmentation, with saliency map computation. The team is engaging with doctors from several hospitals like NIMHANS, Kauvery Hospital to obtain feedback for improving the module.

Current Status:

- Proof of concept – The team has carried out pilot studies and completed the 2D segmentation module. They are currently working on multi-tasking framework module for simultaneous classification. However, it is too early for application since the sample size used is very small. Model will have to be refined after usage on a larger dataset.
- The team has shared the 2D model as a Toolbox on GitHub as an executable and run it on their own data.

Next Steps:

- The team will work on model interpretability, improving system performance, and integration to build an end-to-end system.
- Paper on FewShot Learning will expected to be submitted in an academic journal; work is under progress.

6. Medical Images Segmentation

Develop techniques for identifying 'super-pixels' in medical images based on self-supervision learning.

Project duration: August 2021 – 2023 *(estimated)*

There is a continued need for accurate segmentation of anatomical structures (liver, kidney, lungs, heart) and lesions from CT scan and MRIs for the diagnosis of various diseases. Tools based on supervised techniques will require large annotations in medical images which are expensive, complex, and not standardised. The project aims to develop self-supervised learning-based medical image segmentation techniques which will be generic in nature for all kinds of available datasets. The techniques will support identification of 'super pixels' in medical images using available datasets for lungs (COVID-19 lesion segmentation dataset), abdomincal organs and heart datasets.

Current Status:

- Proof of concept – Training of super-pixel learning method for medical images (RGB images) has been completed and used for segmenting abdominal organs in CHAOS – Abdominal MRI dataset.

Next Steps:

- The team will work on contrastive learning approaches and hyper correlation based methods to learn few-shot segmentation in RGB images.
- The team is currently working with publicly available data and plans to tie up with NIMHANs for larger data sets.
- The team believes that this technique can be adopted by medical imaging technologies to be used in software that can interact with diagnostic devices.

7. Automatic Data Processing

Generate a structured output from a scanned image.

Project duration: September 2021 – December 2022 *(estimated)*

Digitising data in hard copy formats (invoices, reports, and documents) requires data to be manually fed into a computer system. This takes a lot of time and effort. Optical Character Recognition (OCR) technology is commonly used to recognize text in scanned documents and images. However, OCR systems may not work on images of varied formats because poor image quality, scanning noise, watermarks in the document background, etc. The project aims to develop an OCR tool that can extract information from any input to a structured output in XML format. The team is working on high structural entity detection from image documents such as text, title, table, figure, list.

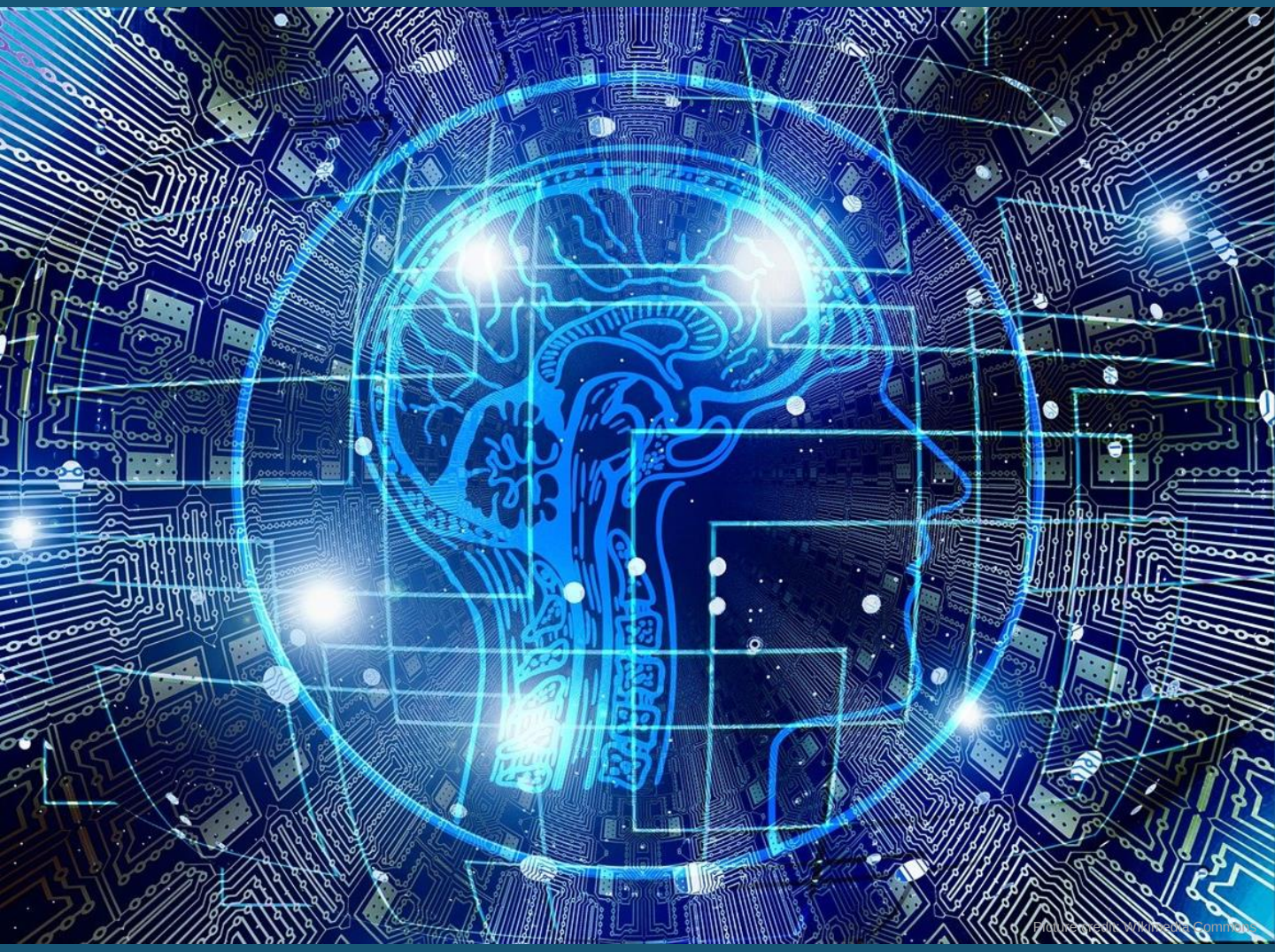
The team has identified potential uses of this system for hospital information systems (health records); research (for summary data - system can help in showing all plots and tables in one place, number/order of paragraphs, and data); text to speech for visually impaired (system can read data from scan of an image).

Status:

- Proof of concept – The team is working on table detection using binary classifier using word level features.

Next Steps:

- The team will continue to work on entity detection and improving OCR results till December 2022.
- Toolbox/web application will be put up on GitHub.



Chapter 3

SoStakes' Approach and Methodology

SoStakes' Approach & Methodology

3.1 Objectives of the Impact Assessment

This impact assessment seeks to

- Assess the contributions made by the CoE's activities since its inception; and
- Provide critical feedback and learnings that can be useful in improving the programme.

3.2 a) Research Design

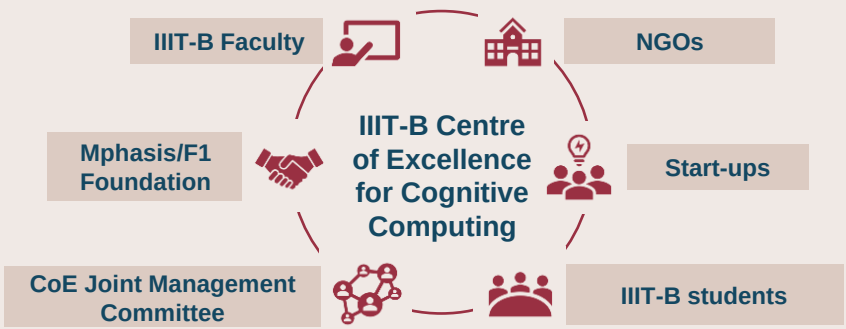
Secondary data analysis:
The following were reviewed –

- Research Project Reports
- Workshop videos
- Research papers
- Programme agreements (MoUs, Amendments)

Research approach:
This assessment is being undertaken during/near completion of the research phase. Hence, traditional impact assessment methodology depending on primary data collection from beneficiaries was not used. Thus, this IA has focused on:

- CoE's management process;
- Research projects; &
- Progress in terms of outputs that were part of the impact matrix at the time of its inception.
    - Proof of concepts;
    - Open source sharing;
    - Publications in conferences/journals.
- Partnerships and collaborations with NGOs and start-ups.

Stakeholder map:



3.2 b) Data Sources

Primary data: Qualitative data collected from key stakeholders via semi-structured in-depth interviews. The Interviews were conducted on video and telephone calls.

	Type of Respondent	No. of respondents
1.	IIIT-B faculty members	11
2.	IIIT-B students (PhD/MTech/RA)	4
3.	Joint Management Committee members	2
4.	Start-ups/NGOs	4
	Total	**21**

ii. Secondary data: Project progress reports, and project process documents were provided by IIIT-B. Workshop videos and published research paper were obtained from IIIT-B website.

3.2 c) Ethical Considerations

- ✓ Prior consent was taken from the respondents (beneficiaries/stakeholders) interviewed for the study.
- ✓ The respondents were informed about the purpose of the study, as well as the ways in which the information provided would be used.
- ✓ SoStakes ensures confidentiality of data shared.

3.3 Framework for Evaluation

We have relied on the DAC/OECD standards of Relevance, Effectiveness, Efficiency and Impact for this evaluation. The OECD (Organisation for Economic Co-operation and Development) standards are aimed to improve the quality of, and strengthen the evaluation process. Evaluation practitioners widely use them for improving developing outcomes.

Parameter	Description
Relevance	To assess whether the intervention was a right fit for the identified needs.
Effectiveness	To assess whether target outputs and outcomes were achieved.
Efficiency	To assess the measures undertaken to improve the efficiency of programme implementation.
Impact	To assess the contributions of the projects, in terms of social value, for the beneficiaries.

Picture credit: Wikimedia Commons

Chapter 4
Findings and Impact

Findings and Impact

4.1 Relevance

The National Strategy on Artificial Intelligence (NSAI) Discussion Paper 2018 by NITI Aayog highlights AI's economic and social growth potential. NSAI emphasizes the use of AI to solve national challenges in inclusivity, agriculture, health, and education. The paper mentions the role of AI in improving the delivery of services (remote diagnosis or precision agriculture advisory) and enhanced inclusive access to welfare services. NSAI emphasizes the need for a robust ecosystem for facilitating cutting-edge research for solving societal problems and has included 'promotion of research' as one of the recommendations for developing and promoting AI.

Mphasis and IIIT-B's partnership to establish the CoE aligns with this national strategy. CoE aims to contribute to finding solutions for the social sector and building a knowledge leadership in cognitive computing and its sub-domains. The Centre is an important platform that provides opportunities to students and faculty to explore ideas and undertake cutting-edge research in cognitive computing.

At CoE, the approach has been to work in strategic partnership with startups and NGOs to identify needs, challenges, and solutions for research projects. The Centre organised a symposium in 2018 and invited NGOs working in education and accessibility to discuss specific needs and challenges in these domains and discuss viable technology solutions that could be used to address these challenges. In accessibility, the Centre has supported Friends for Inclusion (an NGO) with the technology to develop an application that is expected to help the hearing impaired. In education, they have worked with Gooru Labs to support online learning through personalized pathways based on learning maps. BelYo, a COVID-19 project, was in partnership with startups chosen for their potential to deploy it urgently.

While phase 3 projects focus on research on improving deep learning methods and healthcare assistive technology is meant to be of immense use in their respective sectors, the projects have not identified immediate partners or strategies for application.

4.2 Effectiveness

The programme has identified the following as indicators of effective programme performance:
a) Research projects: proof of concepts, prototypes, and research papers;
b) Workshops: number of workshops conducted by project faculty.

4.2.a. Research Projects

Proof of Concepts:

- All three first-phase projects of 2018 have successfully developed proof of concepts and prototypes.
- Phase 2 COVID-19 projects, BelYo and CDSS, have been completed.
- Among the projects initiated in 2021, prototypes for Generalised Wasserstein Deep Forest, Remotely Accessible Lab, CT Scan Analysis, and Medical Images Segmentation have been completed, and the teams continue to experiment with extended datasets and work on improvements. Community Discourse Modelling, Deep Generative Model, and Automatic Data Processing are in their initial stages.

The table below captures the research projects and their different degrees of completion:

Project completed	Proof of concept developed	Proof of concept work in progress

	Project	Status
1.	Indian Sign Language#	• Gesture animation for 1300 words has been completed. • Mapping to avatar prototype completed.
2.	Navigated Learning#	• Competency maps, web portal and trailer generation codes have been created.
3.	Data Anonymization#	• The tool development is complete.
4.	BelYo#	• The blockchain-based platform has been developed.
5.	Clinical Decision Support System#	• CDSS platform has been developed. • The APIs have been made available for developers working on similar healthcare applications.
6.	Community Discourse Modelling	• The project is in its early stages. The team is working on speech to text conversion.
7.	Generalised Wasserstein Deep Forest#	• The framework and mathematical formulation of GWDF model is ready.
8.	Deep Generative Model	• The team is experimenting with classifier on available datasets (satellite images), and analysing data.
9.	Remotely Accessible Lab	• Traditional control approaches of speed control of a DC motor has been tested successfully. • 8-10 experiments have been conducted.
10.	CT Scan Analysis#	• The team has carried out pilot studies and completed the 2D segmentation module.
11.	Medical Images Segmentation#	• Training of super-pixel learning method for medical images (RGB images) has been completed and used for segmenting abdominal organs in CHAOS – Abdominal MRI dataset.
12.	Automatic Data Processing	• The team is working on table detection using binary classifier using word level features.

The code has been shared on GitHub.

4.2.b. Research Papers

ISL, Navigated Learning, and Automated Document Processing projects have presented papers in 3 international conferences and published in 2 academic journals. The table below captures conferences attended and papers published (*complete details given in annexure*):

Project		Topic	Publications/Conferences
1.	Indian Sign Language Synthesis	Virtual Indian Sign Language Interpreter	• 4th International Conference on Vision, Image and Signal Processing, 2020
2.	Navigated Learning	Automatic Title Generation for Learning Resources and Pathways with Pre-trained Transformer Models	• International Journal of Semantic Computing (IJSC), 2021 • 15th IEEE International Conference of Semantic Computing, 2021 *(nominated for Best Paper Award)*
		Creating Navigable Competency Maps from Learning Resource Corpora	• International Conference on Data Science and Management of Data (CODS-COMAD), 2021
		Characterization of Technology-based Mediations for Navigated Learning	• Advanced Computing and Communications Systems Journal
4.	Automated Document Processing	A Hybrid Approach for Table Detection in Document Images	• 5th Workshop on Document Analysis and Recognition in conjunction with the Indian Conference on Computer Vision, Graphics and Image Processing (ICVGIP) 2021

4.2.c. Workshops

The CoE faculty organize regular public talks as part of idea and knowledge-sharing exercise. These talks are shared with the public via the IIIT-B website.

1. Samvaad – Samvaad, as an initiative, was started in January 2018 to provide a platform and enable a dialogue among the different research initiatives going on at IIIT Bangalore. The initiative features a public talk by 1 faculty member every week, introducing the ideas and questions that they are pursuing as part of their research. The objective of Samvaad is to enable cross-fertilization of ideas, and develop strategic research collaborations between members of the faculty, as well as with external partners.

118 Samvaad sessions:
- 2018 – 24 talks
- 2019 – 26 talks
- 2020 – 38 talks
- 2021 – 30 talks

10 workshops conducted in WSL

2. Web Science Lab (WSL) – WSL conducts research workshops at the end of every semester at IIIT-B. The workshops are aimed to share, discuss and reflect upon the research conducted in the preceding semester. Researchers (faculty and students) present their latest work and a demo.

4.3 Efficiency

We have assessed the CoE's management structure and periodic review mechanism that have contributed to the efficient implementation of the CoE's activities.

4.3.a. CoE Management

The CoE management has been structured to ensure alignment of its activities with Mphasis' larger vision of technology for social impact. The CoE is headed by a joint Management Committee consisting of Mphasis and IIIT-B leadership. The Committee has played a critical role in setting up the Centre and determining its strategic approach. The Committee's expertise in the field has provided critical direction in determining the sectors and research ideas.

4.3.b. Periodic Review Process

The CoE has a process for periodic review of research projects. Research teams present their projects and progress to the Joint Committee. However, review meetings for 2021 have not been regular.
Also, it has to be noted that while codes are shared on GitHub, project teams are not actively monitoring the GitHub platform to note the use of the IP assets shared.

4.4 Impact

The research projects rely on collaborating partners/non-profits for solutions to be adopted and used to address various social problems. The following projects were able to see the application of their research in the following areas –

BelYo

BelYo (by Belfrics and YoSync) was developed for digitizing and enabling access to people's COVID-19 data (vaccination, COVID infection) by COVID-tracking apps like Aarogya Setu. The platform was not integrated into Aarogya Setu/COWIN, however the teams have expanded the applicability of the platform for management of a wider set of healthcare and other data.

Belfrics has signed an exclusive MoU in March 2022 with Red Cross Society of Kenya for use of the blockchain platform for the management of health data in IFO2 hospital Dadaab, Garissa County.

Clinical Decision Support System

PHIA, PRADAN, and Transform Rural India (NGOs) supported by Azim Premji Philanthropic Initiatives (APPI) used the CDSS platform through the e-JIDHAN App in Jharkhand to screen patients during the 2nd COVID-19 wave (April – July 2021).

The application was used by non-medical frontline workers across 2091 villages in North and South Chhota Nagpur Plateau, Jharkhand for conducting door-to-door screenings of villagers for COVID symptoms. The platform helped in coordination of medical equipment and oxygen in PHC's and CHCs, and in setting up test camps and isolation centers.

The IIIT-B team believe that the platform could be used for addressing various healthcare challenges such as screening children suffering from malnutrition.

Navigated Learning

Gooru (an NGO) has used the Learning Maps to create applications for Navigated Learning and has implemented it in 3523 schools (covering 72 lakh learners) across North America, Asia, Australia, Africa and India. Customised Navigators apps are available for learners, instructors, administrators and researchers.

In India, they have created applications for use by teachers in Chattisgarh and Tamil Nadu. In addition, Gooru has partnered with Sampoorna Swaraj Foundation to impart COVID training to Anganwadi workers. They have also prepared competency models and training materials to guide local elected representatives with knowledge about governance in the Panchayati Raj system.

ISL Synthesis

Friends for Inclusion (an NGO) used the ISL machine translation framework created by IIIT-B to develop a signer application named Sign IT for teaching sign language to the hearing impaired community. The app offers a dictionary, and translation services.

Key Takeaways

Mphasis Foundation's current programme is an innovative approach to CSR. There are two aspects to the programme – i) research, ii) application of the research for solutions to create social impact.

In phase 1 of the programme, the CoE focused on taking up research projects which had social relevance/impact by partnering with NGOs. This design met with considerable success, as two out of the three projects were taken up by NGOs for a more extensive outreach.
The phase 2 projects responded to the pressing needs of dealing with the COVID -19 outbreak.
During the phase 3 project selection, the CoE felt that partnering with NGOs slowed down the number of research projects that could be undertaken. Hence, the focus moved to adopt more leading-edge research projects.
Further, as per the CoE's commitment towards knowledge-sharing, the teams have shared their research prototypes/codes on an open-source platform (GitHub). This has contributed towards making AI-related technology, with the potential to solve issues in the social sector, available to a larger audience.

Recommendations

The CoE can continue exploring partnerships to translate the research into an outreach programme. For example, future programme design could include funds for non-profits to support outreach. It may also be worthwhile to assess the capacity for technology adoption by the non-profit/social enterprise ecosystem.

Several projects in phase 3 have broader applicability – it is felt that narrowing the research applicability would help to strengthen use case possibilities.

It is crucial for the periodic review process to be resumed (after being paused in 2020-21) to provide timely feedback and direction to the research teams from the Joint Management Committee of the CoE.

The research teams have not tracked the engagement of external parties on GitHub uploads. Going forward, monitoring engagement on GitHub and a more targeted approach for knowledge-sharing could improve research applicability in the future.

Paper presentations and publications

A. Presentations:

I. Krishna, S., Jindal, A.R. Jayagopi, D.B. (2020, December 9-11). *Virtual Indian Sign Language Interpreter*. [Conference presentation]. 4th International Conference on Vision, Image and Signal Processing 2020, Bangkok, Thailand.

I. Mishra, P., Diwan, C., Srinivasa, S., Srinivasaraghavan, G. (2021, January 27-29). *Automatic Title Generation for Text with Pre-trained Transformer Language Model*. [Virtual conference presentation]. 15th IEEE International Conference on Semantic Computing 2021, United States.

I. Kumar, V.N.S, Diwan, S., Srinivasa, S., Ram, P. (2021, January 2-4). *Creating Navigable Competency Maps from Learning Resource Corpora*. [Conference presentation]. International Conference on Data Science and Management of Data (CODS-COMAD) 2021, Bengaluru, KN, India.

I. Vengalil, S.K., Xavier, K., Konda, A.K., Barma, G., Sinha, N. (2021, December 19-22). *Hybrid Approach for Table Detection in Document Images* [Conference presentation]. 5th Workshop on Document Analysis and Recognition, Indian Conference on Computer Vision, Graphics and Image Processing (ICVGIP) 2021, Jodhpur, RJ, India.

B. Publications:

I. Mishra, P., Diwan, C., Srinivasa, S., Srinivasaraghavan, G. (2021). Automatic Title Generation for Learning Resources and Pathways with Pre-trained Transformer Models. *International Journal of Semantic Computing*, 15(4), 487 – 510. https://doi.org/10.1142/S1793351X21400134

II. Lalingkar, A., Srinivasa, S., Ram, P. (2019). Characterization of Technology-based Mediations for Navigated Learning. *Advanced Computing and Communications Systems*, 3(2), 33 – 47.

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https://www.forbes.com/sites/bernardmarr/2018/04/30/27-incredible-examples-of-ai-and-machine-learning-in-practice/?sh=fdb33c575022

II. "Introduction to AI for Social Good"
https://towardsdatascience.com/introduction-to-ai-for-social-good-875a8260c60f

III. "AI for social good: unlocking the opportunity for social impact"
https://www.nature.com/articles/s41467-020-15871-z.pdf

IV. "AI + Sustainable Development Goals"
https://ai4good.org/ai-for-sdgs/

V. "Responsible AI – Approach Document for India"
https://www.niti.gov.in/sites/default/files/2021-02/Responsible-AI-22022021.pdf