



ashoka  
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# ARTIFICIAL INTELLIGENCE

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A COLLECTION OF  
**POLICY BRIEFS**  
ON AI

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2020-21







# ARTIFICIAL INTELLIGENCE

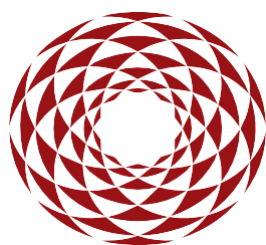
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We stand at the threshold of a fundamental discontinuity brought about by the confluence of at least two parallel developments viz. (i) an increased ability to sense and produce enormous amounts of data (the digital universe continues to double every 2 years), and (ii) the ability to create extremely large clusters driven by parallel runtimes. These developments have enabled machine learning and other data-driven approaches to become the paradigm of choice for complex problem solving across domains.

Bearing this in mind, we at Ashoka University have been promoting these opportunities among students through our teachings, laboratory research and workshops in Artificial Intelligence, Machine Learning and other fields of Computer Science; thereby helping students become proficient in the application of these technologies to their areas of interest.

Besides the curriculum, workshops and conferences are effective in promoting a broader perspective and ensuring a collaborative environment that is so essential to the larger discoveries that await us at the fringes of individual disciplines. The webinar on Artificial intelligence held last year in July is one such example of a successful stakeholder-researcher-student engagement. Experts who were invited to give a talk on AI at the webinar have been continuously engaged with Ashoka and have been generously contributing their insights in preparation of this policy compendium.

I congratulate the Science Policy Cell of Ashoka for coming out with this publication on an extremely pertinent subject. I am hopeful that this will help in generating many more insightful discourses in AI among policymakers, practitioners, academicians, industrialists, etc.

**Ravi Kothari**

Ex-Professor and Head of Computer Science  
Ashoka University



On 17 July 2020, Ashoka organized an interactive online meeting on Artificial Intelligence, inviting senior policy experts, academicians and industry leaders from across the country to exchange views and discuss the subject from policy perspectives. This was organized by Prof Ravi Kothari, an eminent scholar in this area, with support from the Ashoka's Science Policy Initiative (SPI).

This Collection of Policy Briefs on AI is an outcome of that meeting. We have made an attempt to bring forth the critical issues surrounding AI, which emerged during the course of the day-long webinar and have elaborated the same in this compendium.

SPI at Ashoka was set up in 2019 to complement the efforts of the University in policy domain and spur innovation as well as continuous learning into the knowledge ecosystem. SPI aims to promote data-driven and evidence-based research, policy work and advocacy on India's science, technology and innovation. Science and Technology is instrumental in enhancing scientific innovation, economic performance and social well-being. Artificial Intelligence is significantly transforming the S&T landscape by revolutionizing human-computer interactions. As one of the fastest growing economies with the second largest population, India's stake in this AI revolution is enormous and I don't find any reason for the country to not leverage the full potential of it. The COVID-19 pandemic tested our preparedness to fight unforeseen crisis and revealed many gaps and weaknesses in protecting lives and livelihoods. In this context, it becomes all the more essential to develop and enhance the use of AI and allied technologies especially in healthcare,



to strengthen our analytical skills and prediction capabilities.

I am hopeful that this publication on AI will serve as reference guide for designing roadmaps, strategies and policy implementation on the subject; or at best be an intriguing read for all sections of the society – policymakers, industrialists, academicians, practitioners, researchers and students – and helpful in addressing some of the challenges and issues on AI.

Special thanks to Prof Ravi Kothari for organizing the brainstorming meeting on AI and all the speakers and authors of this compendium, without them this would not have been possible. Thanks to Dr. Anjali Taneja for relentlessly working to bring this compendium out in consultation with all the experts.

Look forward to your feedback!

**L.S. Shashidhara**

Professor of Biology and Dean of Research  
Ashoka University

## ACKNOWLEDGEMENT

This publication on Artificial Intelligence is the outcome of an interactive virtual webinar on AI which was organized by Ashoka University on July 17, 2020. Distinguished experts from the academia, industry and the government were invited to talk and discuss on different dimensions of AI deployment across domains such as healthcare, supply-chain, education and research, agriculture, policymaking, etc. We would like to thank all the esteemed panelists who joined us at the webinar and shared their expertise and views on the subject. Our sincere thanks to Prof. Ravi Kothari, Professor of Computer Science at Ashoka University for his guidance and active participation, right from the stage of planning and preparation to the actual execution of the interactive event and in developing this compendium.

We are also grateful to the experts, Dr. Alpan Raval, Dr. Avik Sarkar, Prof. Sudeshna Sarkar and Prof. Samir K. Srivastava who shared their insights as distinguished panelists not only during the webinar but also after. They were consistently contributing their inputs and thoughts on a regular basis which were quite useful in putting together the content of the key chapters of this Compendium.

Last but not the least, we would like to express our gratitude and thank Ashoka University as well as its Office of Research for all the support, cooperation and encouragement rendered in the preparation of this compendium. We gratefully acknowledge the support offered by Mr. Sumit Kumar from Ashoka University

**Dr. Anjali Taneja**  
Associate Director (Science Policy Initiative)  
Office of Research  
Ashoka University

**Prof. L.S.Shashidhara**  
Professor of Biology  
Dean of Research  
Ashoka University

## ABBREVIATIONS

AI	Artificial Intelligence
BIS	Bureau of Indian Standards
CORE	Centre of Research Excellence
CSTS	Centre for Studies on Technological Sustainability
DISHA	Digital Information Security in Healthcare Act
EHR	Electronic Health Records
GDP	Gross Domestic Product
GoI	Government of India
GPAI	Global Partnership for Artificial Intelligence
GrSCM	Green Supply Chain Management
GVA	Gross Value Added
HCI	Human-Computer Interaction
HIV	Human Immunodeficiency Virus
ICTAI	International Centre for Transformational AI
IoT	Internet of Things
ISO	International Standards Organization
MCI	Medical Council of India
ML	Machine Learning
MoC	Ministry of Commerce and Industry
MSMEs	Micro, Small and Medium Enterprises
NEP	New Education Policy
Niti Aayog	National Institution for Transforming India
NLP	Natural Language Processing
NSQF	National Skill Qualification Framework
R&D	Research and Development
SCM	Supply Chain Management
SDGs	Sustainable Development Goals
STEM	Science, Technology, Engineering, Mathematics
TB	Tuberculosis
V2V	Vehicle-to-Vehicle
WHO	World Health Organisation



Artificial Intelligence (AI) is transforming the global technological landscape with socio-economic implications on economies worldwide. In India, it holds significant scientific and economic potential. AI is widely being deployed across all major sectors such as manufacturing, agriculture, healthcare, retail, banking, financial services, public utility, and also being used for national defense and security. The market size of AI is growing rapidly over a period of time. With the nation striving to become a US\$ 5 trillion economy in the coming years, AI could perhaps be the next generation technology tool to achieve the target.

Considering the increasing scope and relevance of AI in the Indian context, Ashoka University organized an engaging webinar on AI on July 17, 2020. The virtual conference was organized to promote knowledge exchange, policy advocacy, dissemination of state-of-the-art research in AI and strengthen academia-industry collaborative efforts in the field.

Held under the title 'Artificial Intelligence in India: Enabling a Robust AI-driven Technology Ecosystem in India', the webinar comprised a panel of distinguished experts specializing in AI who spoke about their insights and experiences in the field ranging from academic learnings to practical applications and policy implications of AI. The conference was structured to foster discussions on six primary sub-themes, namely AI in the education sector, in healthcare, for supply-chain management,

core AI, for social good and its policy dimensions in the context of India.

The invited panelists were Prof. Pushpak Bhattacharyya (Professor, Department of Computer Science and Engineering, IIT Bombay and Ex-Director, IIT Patna), Dr. Manish Gupta (Director, Google Research India and Infosys Foundation Chair Professor, IIIT Bangalore), Dr. Alpan Raval (Head, Data Science, Wadhvani Institute for Artificial Intelligence), Dr. Taposh Roy (Manager, Data Science & Innovation, Health Care Delivery Innovation and Delivery System Planning, Kaiser Permanente), Dr. Avik Sarkar (Visiting Professor, Indian School of Business and previously, Head, Data Analytics Cell, NITI Aayog), Prof. Sudeshna Sarkar (Professor, Department of Computer Science and Engineering and Head, Centre of Excellence in AI, IIT Kharagpur), Dr. Gautam Shroff (Senior Vice President, TCS Fellow & Head, TCS Research, Tata Consultancy Services), Prof. Samir K. Srivastava (Professor and Dean, Research, IIM Lucknow), Prof. Partha Pratim Talukar (Associate Professor, Department of Computational and Data Science, Indian Institute of Science and Founder KENOME), Prof. Mayank Vatsa (Professor and Swarnajayanti Fellow, Department of Computer Science and Engineering, IIT Jodhpur & Project Director, iHUB Drishti) and Ms. Madhu Vazirani (Principal Director, Accenture Research).

This interactive conference was well received by the participants and we at

Ashoka University decided to make this knowledge exchange a continuous process. The Compendium on AI is a result of one such policy initiative which we have been consistently pursuing at Ashoka.

A collection of policy briefs on some of the pressing issues concerning AI, this publication has been put together based on the talks delivered by such AI experts invited at the virtual conference last year and in consultation with them.

The compendium comprises 7 chapters including 5 main chapters covering AI's deployment and potential use in areas like social good, AI ethics in healthcare, education, supply-chain management and the enabling policy framework for its effective deployment in India. Each core chapter underlines a status update, key challenges and issues at hand concerning AI's deployment in a particular field as well as a roadmap for future or policy recommendation for its effective implementation. The Introduction and Conclusion chapters of the publication examine the potential, scope of AI in India, the ongoing national initiatives vis-à-vis rest of the world and underline various suggestions to reap benefits from its growing deployment in India. The Chapters are supported by a detailed bibliography towards the end and an Annexure of profiles of the various experts who have co-authored the chapters.

We are hopeful that this Compendium will be useful for students, youth, practitioners, researchers, policy experts and all the relevant stakeholders from the

government, academia and the industry, for a comprehensive understanding of the existing issues at hand in AI and ensure effective policy advocacy in this field in India.

Happy reading!



The background is a dark blue gradient with a pattern of white binary digits (0s and 1s) scattered throughout. In the center, the letters 'AI' are rendered in a large, bold, light blue font. The 'A' and 'I' are slightly shadowed, giving them a 3D appearance. To the right, a stylized, glowing blue line-art robot arm is visible, extending from the right edge towards the center. The arm is composed of various geometric shapes and lines, suggesting a complex, mechanical structure. The overall aesthetic is futuristic and technological.

**AI**

**CHAPTER 1.**  
**INTRODUCTION**

**ce**



# INTRODUCTION

Artificial intelligence (AI), boosted by Machine Learning (ML), computer vision and the Internet of Things (IoT), is increasingly emerging as significant enabling technology. It is widely being deployed across all major sectors such as manufacturing, agriculture, healthcare, retail, banking, financial services, public utility and also for national defense and security. As a result, the market size of AI is growing rapidly over a period of time.

AI is expected to contribute significantly to India's growth, development and employment generation. Data projections are quite positive. AI is estimated to add ~ 1 trillion to the Indian economy by the year 2035. Similarly, it has the potential to absorb over 9 percent of India's workforce in new employments and could contribute nearly \$9 billion to farmers' incomes in the future.

## ARTIFICIAL INTELLIGENCE

### EDUCATION & RESEARCH

AI can be used to teach or to adapt teaching and/or content for better absorption. Globally, AI enabled tutoring programs, skills-based curriculum and innovative tools for teaching are being adopted to enable accessible and inclusive education. India has witnessed a surge of interests among students wanting to expand their horizon of learning, knowledge and skills development in AI and ML

### POLICY

An emerging focus area of policy development in India. From this perspective, the purpose of a policy on AI is three-fold. First, policy makers could explore the possibility of investing in its development; second, adoption of AI to secure it benefits for the economy as a whole; and third, to ensure that AI is used in a fair and transparent way with unambiguous accountabilities.

### AGRICULTURE

Use of AI to build an ecosystem crucial for precision agriculture. For example, predictive analytics using AI tools could be helpful in generating accurate demand and supply information to farmers that could reduce information asymmetry between farmers and intermediaries and ensure correct price realisation.

### SUPPLY CHAINS

Contextual intelligence to supply chains, can be used to reduce the operating costs in supply chain process, reduce latencies, and manage inventories. AI along with ML can be used to gain new insights into warehouse, logistics and supply-chain management

### BANKING & FINANCE

Has the potential to streamline and optimize processes ranging from credit decisions, quantitative trading, resolve provenance and manage financial risk.

### MEDICINE

Emulate human cognition in the analysis of complicated medical data. It is widely used in synthesis (such as ChemInformatics wherein new drugs are synthesized using deep learning), clinical diagnosis, treatments and prediction of medical results. AI's first usage dates back to 1972 when an AI prototype program was used in treating blood infections.



## Strategies and Plans in AI across the globe: At a Glance

Recognizing the global potential of AI, several countries around the world have introduced strategies and launched national plans on AI, embedded in their respective economic growth strategies.

### CANADA

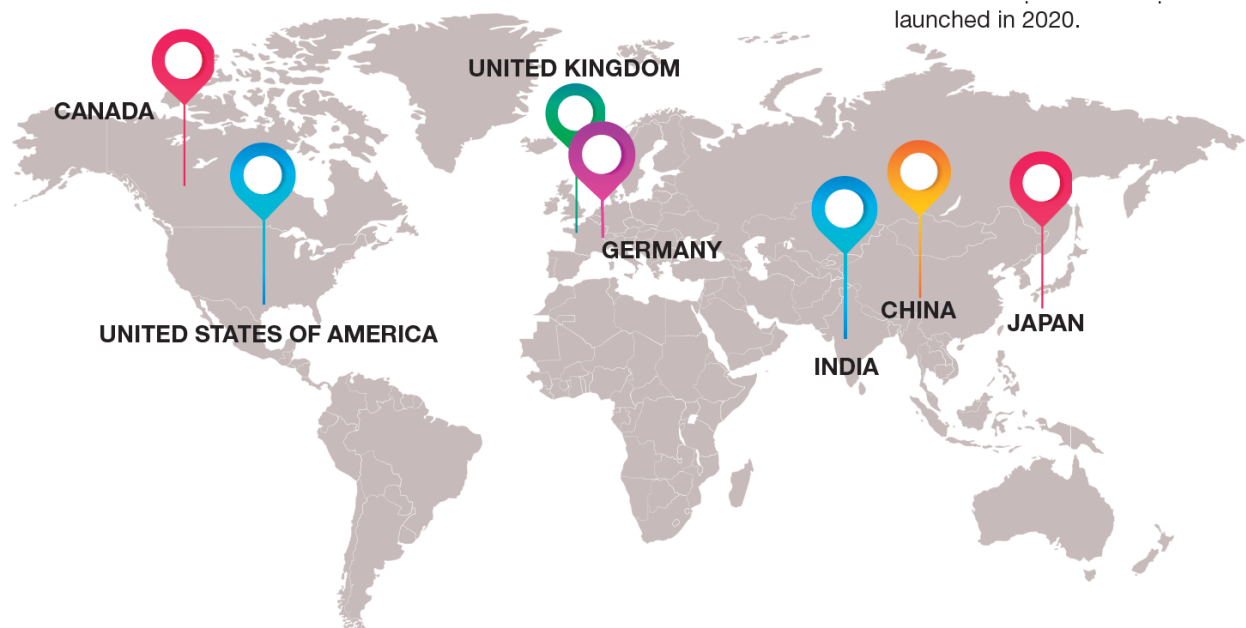
- Pan-Canadian AI Strategy with nearly 25 million allocated in the 2017 budget – led by Canadian Institute for Advanced Research connecting major AI centres
- New Vector Institute for AI in Toronto received \$50mn from the Canadian government and over \$85 million from around 30 large companies.

### UNITED KINGDOM

- Sector Deal for AI announced in the year 2018.
- UK Digital Strategy includes £17.3mn in funding for UK universities to develop AI technologies.
- Several start-ups seeded at the Universities of Cambridge and Oxford and have achieved significant AI breakthroughs.

### CHINA

- Various local, regional governments are taking initiatives; private companies have been investing substantially in AI
- Three-step program released in 2017 for creation of AI industry worth \$150 billion by 2030
- AI Innovation Action Plan for Institutions of Higher Education launched in 2018.
- Beijing AI Principles released in 2019 by a multi-stakeholder coalition of institutes and AI industrial league.
- Dubhe AI open-source plan launched in 2020.



### UNITED STATES OF AMERICA

- Launched the American AI initiative in February 2019: which calls to direct existing funds to AI research, commercialization, and data for AI.
- Released Principles on AI in September 2019
- Vibrant ecosystem of start-ups, technology platforms and large companies typically around big universities.

### GERMANY

- 'AI made in Germany' adopted in the year 2018, plans to invest 3 billion by the year 2025.
- AI is intrinsic to Industry 4.0 and smart factories
- German Research Center for AI is a non-profit public-private partnership.
- Stuttgart-Tübingen area has been transforming into an AI research hub with over 7 industry partners.

### JAPAN

- AI Tech Strategy formulated in the year 2017 and AI was made part of the "integrated innovation strategy"
- AI R&D guidelines drafted; over \$200 million funding parked for two AI research centers in the country.

## INDIA

- AI Task Force set up by MoC, GoI in 2017 to invigorate the use of AI in India's economic transformation.
- National Strategy for Artificial Intelligence #AIforAll drafted by NITI Aayog in 2018.
- Subsequently, 4 Committees were formed by the Ministry of Electronics and Information Technology, GoI in 2019 to enable AI's effective deployment across different sectors and address related concerns like identification of key policy enablers, mapping technological capabilities, cyber security, ethical concerns, etc. The highlights of the recommendations by the Committees: creation of National AI Resource Platform; promotion of a multi-pronged collaborative framework through academia-industry collaborations, centres of excellence, open innovation platforms and international linkages; creation of a National Resource Center for AI in Cyber Security.
- In 2020, India joined Global Partnership for AI (GPAI) as the founding member.
- Among other initiatives, NITI Aayog released an Approach Paper on AI Research, Analytics and Knowledge Assimilation Platform (AIRAWAT), GoI launched a national AI portal and Responsible AI for Youth program.
- GoI has earmarked considerable budgetary outlays and laid considerable focus on investment in AI, data analytics and ML in the annual Union Budgets of recent years.
- As per the 2021-22 Union Budget, the National Language Translation Mission could use AI, ML and speech recognition technologies to build government applications and websites. Deep analytics and AI tools are also being deployed to fight tax evasion in the country. GoI is expected to launch data analytics, AI, ML-driven MCA21 Version 3.0 with additional modules for e-scrutiny, e-adjudication, e-consultation and compliance management.



# WEBINAR ON AI AT ASHOKA UNIVERSITY

Considering the increasing scope and relevance of AI in the Indian context, Ashoka University organized an engaging webinar on AI. The virtual conference was organized to promote knowledge exchange, policy advocacy, dissemination of state-of-the-art research in AI and strengthen academia-industry collaborative efforts in the field.

**The webinar on AI was held on July 17, 2020, and featured renowned academicians, practitioners, policy experts, thought leaders from academia, industry and the government.**

Held under the title 'Artificial Intelligence in India: Enabling a Robust AI-driven Technology Ecosystem in India', the webinar comprised a panel of distinguished experts specializing in AI who spoke about their insights and experiences in the field ranging from academic learnings to practical applications and policy implications of AI. The conference was structured to foster discussions on six primary sub-themes, namely AI in the education sector, in healthcare, for supply-chain management, core AI, for social good and its policy dimensions in the context of India. The flyer and details of the complete program are given at *annexure*.

Prof. Pushpak Bhattacharyya (*Professor, Department of Computer Science and Engineering, IIT Bombay and Ex-Director, IIT Patna*), Dr. Manish Gupta (*Director, Google Research India and Infosys Foundation Chair Professor, IIIT Bangalore*), Dr. Alpan Raval (*Head, Data Science, Wadhvani Institute for AI*), Dr. Taposh Roy (*Manager, Data Science & Innovation, Health Care Delivery Innovation and Delivery System Planning, Kaiser Permanente*), Dr. Avik Sarkar (*Visiting Professor, Indian School of Business and former Head, Data Analytics Cell, NITI Aayog*), Prof. Sudeshna Sarkar (*Professor, Department of Computer Science and Engineering and Head, Centre of Excellence in AI, IIT Kharagpur*), Dr. Gautam Shroff (*Senior Vice President, TCS Fellow & Head, TCS Research, Tata Consultancy Services*), Prof. Samir K. Srivastava (*Professor and Dean, Research, IIM Lucknow*), Prof. Partha Pratim Talukar (*Associate Professor, Department of Computational and Data Science, Indian Institute of Science, Founder KENOME*), Prof. Mayank Vatsa (*Professor and Swarnajayanti Fellow, Department of Computer Science and Engineering, IIT Jodhpur & Project Director, iHUBDrishti*) and Ms. Madhu Vazirani (*Principal Director, Accenture Research*).

## 7 questions to ask for AI for scaled social good

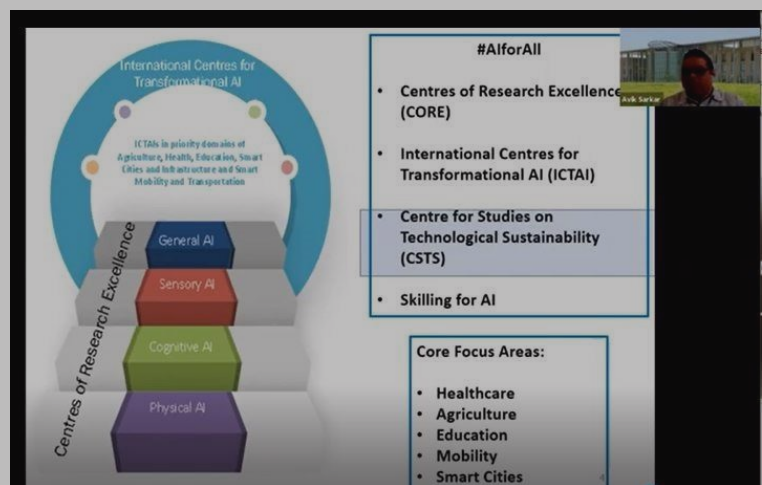
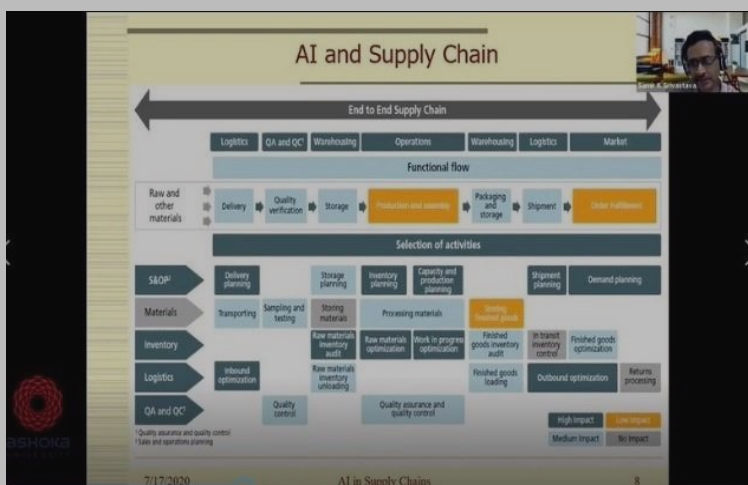
- Is this a big problem?
- Does it have an AI solution?
- Will solving the AI part make enough of a difference?
- Will the solution be accepted by stakeholders?
- Does the data exist, or can it be created easily enough?
- Are there partner organizations who can co-create and pilot?
- Are there programs and pathways to scale?





AI offers tremendous scope for growth and development in India. The talks by the eminent speakers reinforced the potential of AI in problem-solving, skills development, higher education and advanced research, innovation, employment generation and the development of sustainable supply-chain solutions. The conceptual facets of the talks were centered around building an understanding for fundamental gaps in the current state of AI vs natural intelligence (*especially in the pandemic times*) and bridging them; AI's contribution in transforming the education landscape; automatic essay grading and multiple strategies for solving the task including classical classification, deep learning and sophisticated features like reader gaze behavior and the use of embedded knowledge graphs in intelligent decision making.

Among other things, the practical application of AI involves the need for addressing the ethical concerns in demand infusing sectors like healthcare-driven AI applications; robustness issues in building dependable machine learning and computer vision systems; ensuring a robust AI-driven supply chain ecosystem that can be used to generate insights into consumer behavior, public procurement, product and services design, demand estimations, warehousing, logistics and returns management; creating suitable forecasting mechanisms with the help of AI against unforeseen events implementing well-thought-through strategies and proactive policies to accelerate AI-oriented positive social impact and development through collaborative efforts and learnings of global best practices. Ultimately, a vibrant AI ecosystem depends on a robust policy framework reinforced by quality education and research in the field, academia-industry collaborations, a sustainable balancing of start-ups, SMEs, large industries and a thriving culture of innovation.





### Artificial Intelligence (AI): Changing the Face of the World

DEV OPS

### DeepRing: Blockchain+AI

- 1) 'DeepRing' architecture combines CNN architecture with some features of the blockchain technology
- 2) Protect against attacks on AI systems at the "model level"

2020-21 will see more of AI + BlockChain

### Predicting Behaviour: Recommendation Systems

Meta-learning

Learning @ Task .... very well

versus

Learning to Learn

Our weird behavior during the pandemic is messing with AI models

Machine learning models based on correlation are showing cracks - it's going to take a while to get them straight.

### Different Types of Knowledge

Factual

Temporal

Syntactic

Knowledge Graph (KG): Things, not Strings

KG == Multi-relational Graphs

### NLP: a useful view

Problem

Semantics

Part of Speech Tagging

Marathi

French

Hindi

English

Language

Algorithm

CRF

SEM

SEM

Morph Analysis

Discourse and Coreference

Semantics

Parsing

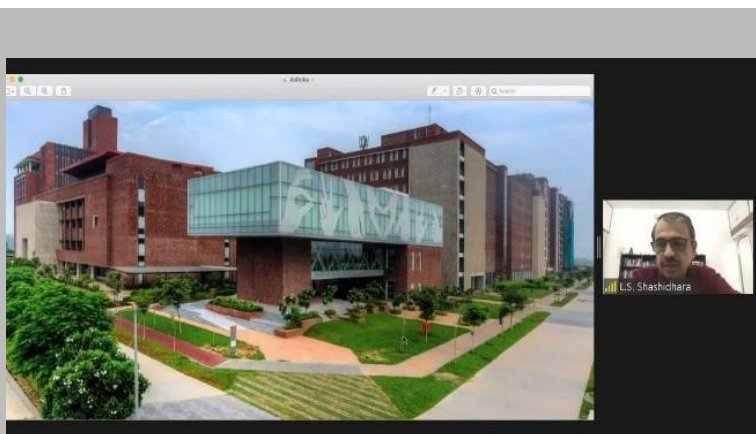
Chunking

POS tagging

Morphology

Increased Complexity Of Processing

*This webinar was well received by the participants and we at Ashoka University decided to make this knowledge exchange a continuous process. The **Publication on AI** is a result of one such policy initiative which we have been consistently pursuing at the University. A collection of policy briefs on some of the pressing issues concerning AI, this publication has been put together based on the talks delivered by such AI experts invited at the virtual conference last year.*



### Opening Remarks

**Prof. Ravi Kothari,**  
Professor & Head of Computer Science at Ashoka University

ASHOKA UNIVERSITY  
FOUNDED 2008







**CHAPTER 2.**  
**ARTIFICIAL INTELLIGENCE  
FOR SOCIAL GOOD**

# ARTIFICIAL INTELLIGENCE FOR SOCIAL GOOD IN INDIA: SHAPING THE WAY FORWARD

Anjali Taneja and Alpan Raval <sup>1</sup>

## I. Introduction

Potentially disruptive technologies like AI have found many use cases in industry and across diverse fields. AI is expected to be a game-changer in years to come, contributing significantly to the gross domestic product (GDP) globally. Rao and Verweii (2017)<sup>2</sup> estimate that the global GDP is expected to be up to 14 percent higher, amounting to an additional \$15.7 trillion, by the year 2030 as a result of AI and that this will lead to improved productivity and consumption-side effects. Even amid the COVID-19 pandemic, according to a McKinsey survey report (2020)<sup>3</sup>, AI has largely been considered by the industry as a tool for generating revenues. Companies, as a result, in sectors like automotive and assembly, healthcare services, pharmaceuticals and medical products, etc, intend to invest even more in AI in response to the pandemic.

On the one hand, AI has enabled automation at scale in replacing humans at tasks that have inherent variabilities, such as face recognition, unmanned vehicle driving, and natural language understanding. On the other hand, AI has allowed computers to learn from a collection of weak signals

or patterns and to be able to extrapolate this learning to tasks that humans may find difficult, such as online recommendations, and predicting how proteins will fold.

The transformative power of AI in both of the above contexts may be applied to improve the human condition. While there is a valid argument that technology companies, by integrating AI into their product offerings, are already doing so, much of the benefits of such disruptive technologies are only to be garnered by the elite among us, rather than by society at large. The term “AI for Social Good” as used in the context of the developed world largely refers to the mitigation of the negative effects of AI solutions, such as the lack of recognition of privacy, the amplification of biases, and unfair decision making.

For the Indian context, and more generally for the Global South, there is a tremendous opportunity for AI-based technologies to bring positive change to lives and livelihoods, healthcare, and agriculture. It is this positive quality, the potential to make a lasting difference in the lives of the under-served using AI that we refer to as AI for Social Good in the context of the Global South. AI employed in this manner can be leveraged to

1. **Dr. Alpan Raval** is the Head of Data Science at the Wadhvani Institute for Artificial Intelligence.
2. Rao, A.S., and G., Verweii (2017). *Sizing the prize: what's the real value of AI for your business and how can you capitalize?* Price Waterhouse Coopers' Global Artificial Intelligence Study (A Report)
3. McKinsey Research (2020). *The state of AI in 2020: Survey*. Mckinsey & Company (online survey).



promote social and economic impact towards meeting the Sustainable Development Goals (SDGs). Education, agriculture, public health, economic development, criminal justice reform, and public safety are just some of the areas where AI can potentially make an impact.

We list below some use cases relevant to the Indian context where AI may be beneficially employed towards social impact. This is by no means a comprehensive list. We describe in further detail the possibilities for AI in agriculture and the eradication of Tuberculosis (TB).

## **Public Welfare**

Public data feeds and public reporting, combined with the growing body of surveillance data, could be used to potentially identify individuals or populations that are in danger of homelessness, or otherwise taking a path that is likely to lead to undesirable personal and social outcomes. This may also be a suitable area to study the interaction of prediction models and the effectiveness of interventions, i.e., heterogeneous treatment effects, similar to the phenomena of behavior change due to clinical decision support. The main challenge here is to balance individual privacy with the need to determine outcomes in advance. AI can also be used to identify unusual patterns in government records, for example, the detection of tax fraud and record de-duplication.

## **Education**

Social feeds, school records, and well-constructed social network-informed

behavioral models can be used to detect school populations that are at risk of falling below a certain grade level and thus inform the deployment of necessary interventions that could influence and change behavior much earlier than is currently possible. The privacy challenge remains paramount here as well, and ideally, this should be carried out only after necessary permissions are obtained. There is also a growing body of work on using AI to do automatic grading of tests at scale, thus enabling teachers and instructors to focus on the task of education rather than be mired in grading work.

## **Public Health**

The mining of health record data to build predictive models to better detect high-risk health events, high-risk populations, and to predict infectious disease spread represents a natural application of AI models. Applications range from proactive pregnancy risk stratification, driving adherence to medication regimens in TB (see below) and HIV patients, finding potential hot spots for infectious diseases, to monitoring nutrition levels and preventing lifestyle diseases like diabetes. Massive population-level screening for diseases is also possible through automated, AI-based analysis of diagnostic scans and cough sounds.

## **Public safety and transportation**

Better data on the location and activities of first responders would enable the creation of datasets that could be mined to create predictive algorithms to better deploy first responders. Similarly, using public transit and other commercial transportation data would

allow researchers to better understand the mobility patterns of people, gaps in transit concerning citizen needs and also to assess the impact of policy changes through data-enabled simulation analysis.

## Disaster response

AI and computer vision methods applied to satellite and drone images have huge potential to aid in preparation efforts for natural disasters like cyclones and wildfires.

## Protecting the environment

AI-based computer vision models also have a significant role to play in combating illegal logging, wildlife poaching efforts, and in detecting pollution hotspots. Conservation efforts can be aided via AI-based analyses of animal sounds deployed in forests at scale and monitored over time to check for the depletion of endangered species.

## **II. Agriculture and Tuberculosis care: The Indian Context**

### *Agriculture*

The agriculture sector of India is the primary source of livelihood for nearly 58 percent of India's population<sup>4</sup>. India is faced with multiple challenges in ensuring the smooth functioning and management of agriculture supply chains. This is primarily because the yield depends very heavily on rainfall, is resource-intensive, degrades with loss of soil fertility and when exposed to pest attacks, and is overall very reliant on external, unpredictable

factors. Therefore, appropriate technological intervention in this sector appears necessary to sustain the livelihoods of the farming community, exports, and seamless supply chain connectivity.

AI-based agricultural technology products and tools could well revolutionize the farming sector of India. Sensors, smartphone cameras, photographs taken by drones, and IoT devices are examples of data streams to AI-based tools that can be deployed to collect agricultural data and supplemented with weather and soil health data. They can then be used to build predictive models to predict crop yield, identify plant disease both as it occurs as well as proactively to direct the usage of pesticides and seeds (pest attacks in cotton farms, for example, are known to disproportionately lead to farmer suicides as a result of the farms being ravaged). Predictive models can also be potentially built to estimate market patterns, demand changes and supply irregularities, and aid in water management. They would help farmers plan ahead and reduce wastage.

A majority of these AI models are expected to be low-cost and to significantly impact productivity. The AI-agro space is estimated to be worth \$4 billion by the year 2026. On the trade front, India is among the 15 leading global exporters of agricultural products across the world. Agricultural exports from India have reached \$38.54 billion in FY19 and \$35.09 billion in FY20. They are likely to rise to \$60 billion by 2022<sup>5</sup>; technologies like AI could aid this meteoric rise.

<sup>4</sup> India Brand Equity Foundation Information Portal (2020). *Snapshot of Agriculture and Allied Industries*. <https://www.ibef.org/industry/agriculture-india.aspx>. Accessed on 14<sup>th</sup> January 2021

<sup>5</sup> *Ibid*

India contains vastly differing soil types, climates and topographies, which create an environment supporting vast and varied data sets and a large pool of information. This allows scientists, ecologists and policy experts to create state-of-the-art ML models, which will not only aid India but can also be used globally. The numerous opportunities for AI in Indian agriculture make it home to an unparalleled sector capable of vast growth.

### **Healthcare: The case of Tuberculosis**

TB is reported<sup>6</sup> as one of the top 10 causes of death worldwide and the leading cause of death from a single infectious agent. Sadly, India carries over a quarter of the world's TB disease burden and about a third of its deaths<sup>7</sup>, even though TB, to a large extent, is curable. Despite the increase in the TB notifications over a while, India continues to report a 17 percent gap in the number of people newly diagnosed and globally reported and the estimated number of people who would have developed TB in 2019<sup>8</sup>. This gap is on account of underreporting of people diagnosed with TB and misdiagnosis. It is estimated that as many as 0.5 to 1 million TB cases<sup>9</sup> may go unreported and therefore untreated in the country each year. As a result, TB continues to remain a serious public health threat.

Why does this happen? Patients are left behind at multiple points in the TB care cascade. There is a lack of awareness, and many patients may remain undiagnosed because they simply don't visit a doctor. Due to inequities in medical care, some patients may be misdiagnosed at the health clinic. Some of those who are diagnosed correctly may never initiate treatment due to a combination of ignorance, social taboos, and economic duress. For the same reasons, and also due to side effects of TB medication, others may begin treatment and not complete it. The cumulative effect of all of these misses is the massive TB burden faced by the country.

We are aware of these problems largely because India possesses one of the world's largest and most comprehensive repositories of patient-level TB data, namely the NIKSHAY<sup>10</sup> system. It is required that every TB patient diagnosed with the disease, whether at a public or private facility, must be reported into Nikshay, and their treatment progress logged. Furthermore, there exist digital automated call logs, known as the 99DOTS system<sup>11</sup>, that monitor adherence to the medication regimen for about 10 percent of TB patients going through treatment. These vast datasets represent a natural entry point for AI technologies.

<sup>6</sup>. World Health Organisation (2020). *Global Tuberculosis Report*. Accessed online on 14th January 2021.

<sup>7</sup>. *Ibid*

<sup>8</sup>. *Ibid*

<sup>9</sup>. Estimates are calculated based on the figures reported in annual WHO reports on TB of various years.

<sup>10</sup>. NI-KSHAY (Ni=End, Kshay=TB) is a web-enabled patient management system (<https://nikshay.in>) for TB control under the National Tuberculosis Elimination Programme. It is developed and maintained by the Central TB Division, Ministry of Health and Family Welfare, Government of India, in collaboration with the National Informatics Centre and the World Health Organization Country Office for India.

<sup>11</sup>. 99DOTS (Directly Observed Treatment, Short-course) is a technology-enabled project focusing on medication adherence for anti-Tuberculosis drugs. It is a mobile phone-based technology that enables real-time remote monitoring of the daily intake of treatment. It was first introduced by the Revised National Tuberculosis Programme under the national programme in 2015 in high-burden antiretroviral therapy centers. Information extracted from <https://www.microsoft.com/en-us/research/project/99dots/> on 14th January 2021.

AI-based solutions can help at various points in the above cascade. They can help carry out population-level risk stratification and pinpoint locations to be screened for missing TB cases. They can help improve (and indeed are improving) X-ray or sputum-based diagnostics for TB, as well as aid in the introduction of novel diagnostic technologies. They can identify patients who are at the highest risk for non-initiation of treatment and those who are at risk of not completing treatment. Development and implementation of these solutions in an actionable manner represent a large endeavor that will require commitment from governments and a challenge for AI in TB care.

### **III. Observations and Recommendations: The Way Forward**

There are many opportunities to carry out focused work in AI for public welfare or social good. However, there are serious challenges too. The key differentiator between an AI agent and a non-AI software product lies in the fact that development, deployment and monitoring are tightly integrated with the former, and this results in a frequent or continuous iteration framework for the AI model. This aspect may represent a significant

Some of the key observations and recommendations for the way forward are:

1. AI research is just beginning to be shaped in applications for social good; this trend needs to be encouraged, understood and supported. In this context, as mentioned above, it is important to keep in mind the tradeoffs involved: while AI can often deliver outsized gains in automation and accuracy of decision-making, the price of doing so is the commitment to a continuous iteration and deployment framework.
2. The setting up of good data pipelines for public and government-owned data is key to the adoption of AI. Quality and completeness of data are paramount considerations. Digitization and data curation efforts must be carried out at scale. State-of-the-art privacy standards must be incorporated while ensuring that non-PII data can be disseminated quickly and easily. The computational infrastructure required to support streaming data must be put in place. Easy data integration and interoperability of data systems are important.
3. The use of the public-private partnership model of collaboration/partnership (academia-government or academia-industry or academia-government-industry) in designing AI prediction models must be encouraged, particularly where complementary expertise and resources can be leveraged. Government involvement is necessary to define actionable use cases and target metrics and to open up data pipelines, whereas technical AI expertise may come from the private sector.
4. Research and modeling closely tied to and dictated by applications, by actual use, is a must in shaping AI for Social Good work. Sound work in this area will lead to questions that are crucial to making a social impact, and in this manner provide innovative research possibilities. For example, in working with social networks in low resource communities; given unreliable and uncertain access to smartphones or other technologies, the



research questions that arise may be fundamentally different, often arising out of insufficient data about the networks. The essential point is to drive the research from its use.

5. Work on AI for Social Good necessarily will require interdisciplinary teams, where part of the team is rooted firmly in the domain discipline, and another part more rooted in the technology, and perhaps yet another part with an understanding of the pitfalls that may arise when the technology is applied to the domain in question.
6. The potentially outsize impact of AI models on society, coupled with the fact that they will be used by people who may not have access to cutting-edge technology, implies that the resulting AI models should be interpretable and transparent as far as possible. It is important for the user to be able to interpret errors made by the models.
7. “Human-in-the-loop” is often an essential part of AI models, and we see this aspect as being even more relevant for Social Good applications. There are various ways in which full automation can and should be curtailed, and key aspects of modeling and decision making left to the human. For example, in risk prioritization for a disease, the AI model output could be channeled as a simple recommendation to the user who is the final decision maker and uses the model recommendation as one of the many inputs into that decision. Humans who use the models may, over time, also develop a good sense of where the models fail and where they work well, and this could be a very important input

to the next set of model iterations. Since many of the AI applications might be in domains with vulnerable populations, the right human-AI interface is important to consider. The issue is not just the human-computer interaction (HCI) aspects, but in a fundamental sense where to draw the boundary between AI and the human interaction with the AI.

*This chapter has been evolved from a talk and based on the inputs of an eminent industry and policy expert, Dr. Alpan Raval who was invited to give a talk at the AI webinar. The title of his talk was ‘AI for Social Good’.*





## **CHAPTER 3.**

### **ETHICS IN HEALTHCARE AI APPLICATIONS**



## CHAPTER 3

# ETHICS IN HEALTHCARE AI APPLICATIONS: IMPLICATIONS FOR INDIA AND SOCIETY

Anjali Taneja and Avik Sarkar<sup>12</sup>

### I. Introduction

The growing popularity of AI across the world has led to several domains adopting AI to improve productivity through service availability and process efficiencies. A large number of applications in the healthcare domain have started adopting AI which

includes automated disease identification like breast cancer, diabetic retinopathy, etc., or chatbots for health advisory, assistance during surgeries, patient health monitoring and admission recommendation.

#### BOX

*According to India's National AI Strategy (NITI Aayog, 2018), focusing on the overall economic growth and impacting the lives of millions of Indian citizens, the primary focus areas of AI adoption in India are healthcare, agriculture, education, mobility and smart cities. Taking a few examples, AI applications in India are increasingly being used for:*

*Precision Agriculture – Several state governments across India have been engaged in pilot projects in the agriculture sector including in the aspirational districts of the Central Government. u These applications involve the use of AI-based real-time advisory based on satellite imagery, soil information, weather data, etc. to increase farm yields and production levels.*

*Healthcare – India has a far lesser number of radiologists, pathologists, or ophthalmologists compared to the numbers specified by global bodies and the issue is even more severe in rural*

*areas. AI can play an important role in augmenting the efforts of these specialist doctors thus expanding the reach of healthcare. The government is working on augmenting the productivity of existing pathologists and radiologists as the first (of many planned) pilot projects in healthcare. Several state governments have worked on early diagnosis and detection of Diabetic Retinopathy and Cardiac Risk using AI models. Such initiatives would in the long run help patients on proactive medication in early stages rather than reactive healthcare in advanced stages – bringing down healthcare costs and better chances of recovery.*

*Indian Languages Project – The Indian government has initiated a long-term project to build a complete natural language processing toolkit and dataset for vernacular Indian languages. This would aid in the development of several conversational applications, like health advisory or career counseling through chatbots and assistants, conversing in various Indian languages.*

<sup>12</sup> Dr. Avik Sarkar is Visiting Professor at the Indian School of Business, Hyderabad and former Head of Data Analytics Cell & Officer on Special Duty (OSD) at Niti Aayog, Gol.

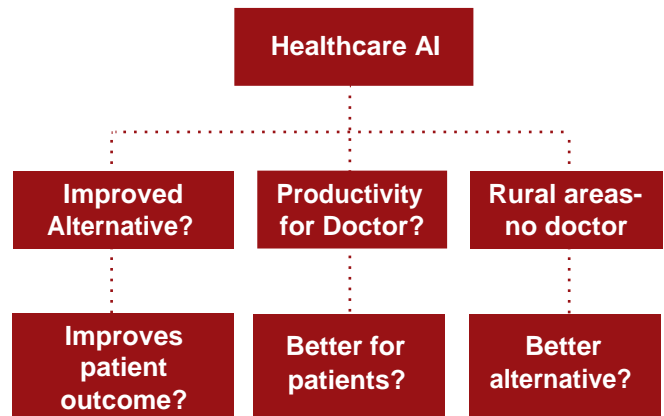
Specifically, in the field of medical sciences, AI applications are being deployed for identifying high-risk patients based on historic medical records of patients, prediction analysis with the help of healthcare trends in the country for building up healthcare facilities and capacities. Moreover, AI is also being deployed to estimate or predict the patients' re-admission risks which are important for the insurance companies as well as predict the costs of assets and infrastructure maintenance in health care centers, clinics, or hospitals. AI tools are also handy when it comes to providing medical transcription research services or for enabling specific ailment or symptoms' diagnosis through healthcare chatbots.

However, several ethical aspects have to be considered while dealing with such healthcare applications. This Chapter describes the various dimensions of AI in healthcare, the ethical concerns and the future roadmap.

## II. Potential of AI in Healthcare

In the field of the healthcare sector, AI is increasingly being used by doctors, clinicians and medical practitioners for early disease detection. An AI research institute in India is using AI tools for detecting child-birth statistics with the help of 3D videos of born children, especially in the rural areas of the country. AI healthcare applications are being used in the medical field to enhance productivity, enable automated consultation and accurate diagnosis of the disease or ailment, especially in the remote areas of the country

What are we then missing?



However, the underlying questions that need to be addressed are whether this is a better alternative for both doctors and patients? Is AI leading to improved patient outcomes across the country need deeper research and evaluation?

Is it enhancing the productivity of the doctors, thus allowing them to serve a wider population?

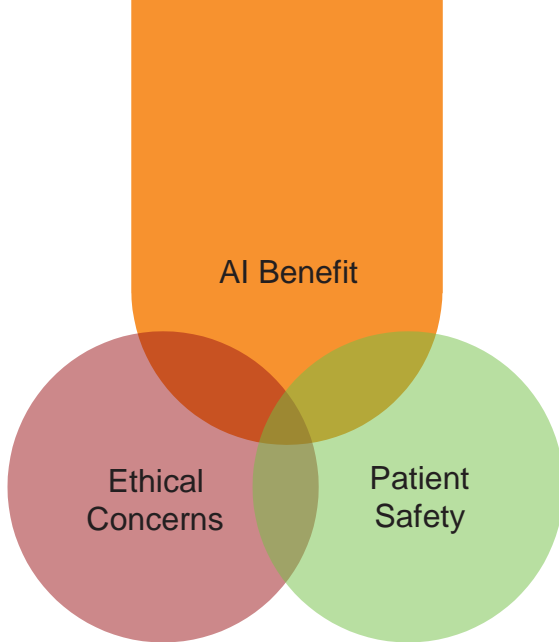
All these questions lead us to evaluate and examine the ethical grounds of deploying AI in healthcare which would lead to a wider acceptability of AI-based solutions across both doctors and patients.

## III. AI Ethics in Healthcare

The primary ethical concerns which must be examined while deploying AI applications in the healthcare sector are:

- automation and job losses
- bias and fairness
- data privacy
- explainability and transparency
- accountability and liability





The deployment of AI technology in healthcare could perhaps lead to a scenario in the future where excessive automation might reduce human interface and doctors ultimately get replaced by robots. Or doctors in the future spend more time in annotating medical data for AI model development rather than attending to patients. However, to avoid such scenarios, possible ethical alternatives should be explored where the use of AI and human interface is balanced out rather than one replacing the other. For instance, in the augmentation model, AI tools can be used for productivity enhancements in visual analysis, prescription writing, etc. At the same time, suitable laws and regulations are formulated that allow automated consultation and doctors can spend more time and effort in attending to patients with empathy and care.

Similarly, when it comes to healthcare data collection and accessibility, the issues of biasness and privacy must be addressed on ethical grounds. For instance, in the case of electronic health records, there might be instances where-in all aspects of patient conditions or co-morbidities are not captured and hence such records are not comprehensively capturing the health

status of the patients. Therefore, the ethical dimension of fairness must be ensured while maintaining medical records or collecting medical data from patients.

Availability of Electronic Health Records (HER) would play an important role in the progress and development of healthcare AI applications. Not only must the data be accurately recorded in electronic format, but the privacy of such data must also be adhered to. In India, at the moment, the Personal Data Protection Bill is under discussion with the Parliamentary Joint Committee. In 2018, the Ministry of Health and Family Welfare has drafted the Digital Information Security in Healthcare Act (DISHA).

Explainability and transparency are equally pertinent ethical aspects towards the development of trustworthy AI applications. For instance, the explainability of AI algorithms is important as predictions of deep learning algorithms are complex to interpret. Doctors and healthcare professionals should be able to understand the reasoning behind the decisions taken by the AI algorithms so that the same can be recorded and discussed with the patients when required. Here comes the role of transparency in communication and interpretations of especially black-box algorithms to maximize prediction accuracy.

Doctors are increasingly using AI prediction tools and applications in the treatments of patients. Accountability and liability are important aspects for consideration in the situation of AI predictions going wrong which can be a multi-party activity. Applications are being designed to support diverse patient scenarios. The doctors must be vigilant about

what can go wrong and they should also know about the potential errors that these AI systems can induce. They should not have over-reliance on automated decision-making systems where people's life is at risk. The final ethical aspect that comes in is when there's a liability occurring due to medical negligence. The principle of reasonableness and appropriate medication is a well-accepted standard for doctors, and it has to be seen whether similar standards can be applied for AI algorithms.

In a nutshell, there is a need for a collaborative understanding of the AI technology system, data and transparency laws for effective usage of AI applications. Besides avoiding over-reliance on automated decision systems, doctors need to be vigilant to potential errors and failures in black box scenarios.

#### **IV. The Road Ahead: Suggestions**

##### **How to derive the benefits of AI?**

The Niti Aayog Discussion Paper (2018) on #AIforAll ideates the need for Centres of Research Excellence (CORE) in AI, International Centres for Transformational AI (ICTAI), Centre for Studies on Technological Sustainability (CSTS) and Skilling for AI. Specifically, the policy architecture governing AI Ethics in India must take into consideration the following suggestions:

1. Establishing Centers for studies in technological sustainability for enabling research and understanding of technological, sociological, economic, political, policy and legal dimensions of AI.

2. Setting up organizations for AI Healthcare Ethics in collaboration with the Medical Council of India (MCI) on similar lines as that of Consortiums of AI Councils (as talked about in the NITI Aayog Discussion Paper).
3. The Bureau of Indian Standards (BIS) is working in collaboration with the global counterparts as part of the International Standards Organization (ISO) for setting up standards for trustworthy artificial intelligence. These efforts would help in setting up standards for AI and also formulate specialized, defined rules, regulations and policy guidelines on certification of AI.
4. Formulating proper regulations and protocols in India governing the public dissemination of information or results (sharing in the public domain) of testing of AI systems deployed among diverse user groups.
5. Widespread and secured use of AI chatbots in Indian vernacular languages to ensure end-to-end awareness and effective flow of information between the end-user and the healthcare professional. Also, ensuring technological advancement in the use of AI chatbots beyond the usual medical advisory and consultations.

*This chapter has been evolved from a talk and based on the inputs of an eminent academic and policy expert, Dr. Avik Sarkar who was invited to give a talk at the AI webinar. The title of his talk was 'Ethical Concerns in Healthcare AI Applications'.*



The background features a complex network of glowing blue and cyan lines that resemble a circuit board or data paths. These lines are interspersed with small, bright dots of the same color, creating a sense of digital connectivity and movement. The overall aesthetic is clean, modern, and high-tech.

## CHAPTER 4.

### ARTIFICIAL INTELLIGENCE IN EDUCATION

## CHAPTER 4

# ARTIFICIAL INTELLIGENCE IN CLASSROOM AND BEYOND

*Anjali Taneja* and *Sudeshna Sarkar*<sup>13</sup>

### I. Introduction

We live in a rapidly changing world – one that is digitally and technology-driven to boost the functioning of any economy. AI has invaded many domains and has the potential to transform all spheres of human endeavor. Emerging India has to prepare the learners of tomorrow for an AI-powered world. Education is the uplifting force that can make us globally competitive. The global landscape is becoming increasingly challenging, and it has become all the more essential to create an educated and skilled workforce.

Education in silos is just not enough to take on the challenges of the technology-driven world. For this to be effective, there must be opportunities and mechanisms for continuous learning, interdisciplinary training and opportunities of reinventing oneself. There is a growing need to reform the curriculum and cultivate a practice of innovative learning to be able to adapt to the changing nature of the job market and industry.

AI has significant potential to transform the education sector. Given the limited resource of high-quality educators, AI can be harnessed to deliver high-quality education at scale. This can be utilized to make the learning experience more innovative, productivity-driven and knowledge-generating for students. It could play a significant role in promoting interdisciplinary research such as studying the science of economics, tackling economic challenges, data-driven forecasting and evidence-based policymaking. Innovative learning encourages students to engage in qualitative research, enhance their critical thinking abilities and nurture their creative learning capacities and problem-solving skills. This chapter examines the vast scope of AI in innovative learning, stressing the need to enable and promote AI-powered education delivery in India.

<sup>13</sup> **Dr. Sudeshna Sarkar** is a Professor in the Department of Computer Science and Engineering and Head of the Centre of Excellence in AI at the Indian Institute of Technology (IIT), Kharagpur



## II. Potential and Scope of AI in Education

AI is unlikely to replace the role of a teacher, but it has the potential to scale up the delivery of high-quality education. The innovative use of AI and allied technologies could improve the usual educational practices, institutions and policies, revolutionize learning and teaching. At the same time, it could empower students in resolving real-time problems through the use of AI prediction and forecasting applications. For example, AI can offer a blend of an online and offline learning experience in terms of teachings of highly modularized courses, those that meet the needs of the teachers and the learners. Similarly, AI can improve learning outcomes through personalized teaching and learning, enable better access to education including connecting learners and mentors across spatial and physical boundaries in collaborative environments. AI-driven teaching services can be personalized – it can gauge the progress of the students, their aptitude, and recommend individualized learning pathways for the students to follow. The vast potential and scope of AI in higher education are beyond the usual classroom learnings:

- 1. Adaptive course delivery and intelligent tutoring system:** AI could make academic learnings more interesting and engaging. It can render flexibility in course offerings by not sticking to a rigid curriculum and molding or adapting the course delivery based on students' aptitude and interests. For example, AI can help break the complex course curriculum into smaller modules to suit students' attention span, engage learners and encourage them to actively participate in learning. Similarly, AI and
- 2. Encourage personalized learning:** AI may be deployed to deliver personalized education catering to different types of learners and to ensure inclusive and equitable access to education. In other words, AI could promote the culture of personalized learning by ensuring learners' monitoring and profiling or generating user profiles (for instance, through sensor-based student monitoring, automated assessment, continuous feedback which guides the learning paths and tracking students' interaction sequences besides teaching sequences).
- 3. Adaptive learning pathways:** AI could enable flexible learning and networking (support exploratory learning beyond boundaries of the institution, connect the student with peers and mentors, recommend courses, modules, activities and problems to solve), promote transfer learning (transfer of user profile from multiple courses and platforms, transfer across learners), connect to long term outcomes. For example, ontology and metadata facilitate search, browse and help explore learning content; Natural Language Processing and text mining can be used to annotate learning content, extract metadata and map resources to disciplinary concepts and pedagogical constructs.

### III. New Education Policy 2020 and AI

The GoI has launched the New Education Policy (NEP) in the year 2020 that aims to change the country's face of education at all levels, primary, secondary and tertiary, making it more technology, practical and skills oriented. The NEP strives to achieve 100 percent youth and adult literacy. The Policy is aimed at paving the way for transformational reforms in the school and higher education system, preparing the youth of this country for next-generation innovation, and research. NEP also proposes a dedicated unit for digital and online learning which is aimed at building the digital infrastructure and online content.

This is primarily factored in to prepare the country with alternative modes of quality education to deal with uncertain times such as the ongoing pandemic, where-in traditional modes of education (classroom teaching, etc) do not work. It also mentions the possibility of developing applications, online courses and modules, satellite-based TV channels and more for seamless execution of education services in the country.

To realize the ambitious goals set by the NEP, it is necessary to take the help of intelligent technology, especially Artificial Intelligence. NEP emphasizes research and innovation and desires that education must emphasize an understanding of key technological concepts, innovative ideas, developing applications and problem-solving skills. To bring about such a transformative change in education, it is useful to make innovative use of digital technology, online platforms and human teachers in a platform for effective teaching and learning.

There is a concerted focus in the document on NEP 2020 for students to receive the education with a focus on skills development in disruptive technologies like AI. We look forward to the right execution of this Policy where AI could also play a role as a facilitator and enabler for its effective implementation.

### IV. Suggestions: Striving for an Inclusive AI-powered Educated India

AI must be harnessed to enable future-proofing of higher education and research. In this section, we list out some suggestions which could be useful to consider in the creation of an inclusive AI-powered education system in India.

- 1. Holistic policy on data management and security to support AI-powered education system:** AI-powered education system can be effectively driven if it is backed up with authentic and secured data collected on various modalities of education and research in AI. This could include data on learning and teaching traces, and gauging students' attention and interest levels in a particular topic with the help of different AI application tools. The development of a data-driven Education Management Information System could be useful in monitoring and evaluating education outcomes, and help in generating effective learning platforms as well as certify and assess the learners. Therefore, a comprehensive policy on data collection for enabling the delivery of AI-centric education is the need of the hour. This policy must essentially cover the security, privacy, standardization and authenticity aspects of data collection.

**2 Implementation is key:** Various policies governing AI and in education, research have been formulated in India. For example, NEP 2020 is visionary and ambitious. Similarly, several deliberations and discussions have taken place over the need for a comprehensive Data Privacy and Security Act. The need of the hour is to not only formulate such policies but also get them into action and implement them effectively. AI could facilitate and support the strategic implementation of the policies ensuring that their inclusivity and equitability are intact. In other words, AI-driven policy enablement must be promoted. Effective policies encourage quality learnings and research, new inventions, innovations as well as cultivate the skills of youth.

**3 Collaborations are important and funding is essential:** AI-oriented research in India is still catching up and needs to be heavily invested in. Existing data reveals that research and innovation in the field are far below the existing potential. According to the H-index, India has been globally ranked at the 17th position. Similarly, for the number of AI-centric research publications or citable research documents in AI<sup>14</sup>. India is ranked behind China, the USA, Japan and the UK. Therefore, the research arena of AI learning in the country falls far behind and calls for urgent bolstering. One of the underlying reasons for such a grim picture is the missing academia–government–industry inter-linkages. The lack of such

engagements and partnerships restrict the growth of research, innovation, and entrepreneurship in the country. The GoI has also reinforced the need for an active engagement of all stakeholders to enable consensus-driven decisions. It is, therefore, imperative to leverage the unique and vibrant R&D ecosystem of India by combining the strengths of government, academia, and the industry.

At the same time, adequate funding support is of utmost importance to promote AI-powered education delivery. At times, the HEIs are unable to cater to the demands for AI-driven education due to inadequate funding or grants to support suitable infrastructure and research capacities at the university levels. Besides, India also lags in essential R&D in AI due to the lack of adequate budget allocation in this field. As a result, the states of India are not equipped or even well versed with the applicability or deployment of AI in resolving state-centric social and economic issues. Moreover, India's tertiary education in AI continues to remain in the nascent stages due to the shortage of necessary funding support, grants and subsidies in this field.

**4 Overcome demand – supply mismatches and job losses via skills development :** The demand for AI in resolving practical problems and forecasting unforeseen calamities is gathering significant pace in India.

<sup>14</sup>. Taneja, A., & R., Kothari (2020), 'Enabling a \$5 trillion Indian economy: A policy framework to catalyze AI-centric technology ecosystem'. Ashoka University White Paper.

On the other hand, against the growing demand, the total number of AI-skilled professionals is lacking in the country and that is where we need to bridge the gap. Upskilling of the youth, students and re-skilling of the workforce can be undertaken through different training programs like the national mentoring program on AI, industry-oriented and need-based curriculum development, creation of mechanisms for decentralized content generation and community-based learning models. It is imperative to create a skills-oriented curriculum for higher learnings and specialization in AI at HEIs. The Universities and research institutes must gear up to ensure that the learnings in AI are progressive, inclusive, skills-oriented and employment generating. In this context, industry - academia collaborations and partnerships are vital.

**5. Enable the growth and development of faculty and teachers:** AI should be used in establishing learning platforms that continuously support as well as augment the development and capacity building of faculty and teachers. The socio-economic aspects of teaching go beyond the simple knowledge transmission through digital mode. Therefore, sustainable online platforms must be designed to work hand-in-hand with teachers, supporting them to deliver courses optimally, assisting the teachers to conduct a fair and effective assessment and catering to a diverse portfolio of students. This will enhance their pedagogy skills and adapt their teaching methods according to the current generation of learners.

*This chapter has been evolved from a talk and based on the inputs of an eminent academic expert, Prof. Sudeshna Sarkar who was invited to give a talk at the AI webinar. The title of her talk was 'AI in the Classroom'.*







## CHAPTER 5.

# ARTIFICIAL INTELLIGENCE IN SUPPLY CHAIN MANAGEMENT



## CHAPTER 5

# ARTIFICIAL INTELLIGENCE IN SUPPLY CHAIN MANAGEMENT IN INDIA: LET'S WALK THE POLICY TALK

*Anjali Taneja and Samir K. Srivastava<sup>15</sup>*

### I. Introduction

AI is one of the most exciting technologies of the 21<sup>st</sup> century. It learns from seemingly unstructured data, takes decisions and performs actions in ways previously unimagined hitherto. Infact, AI uses visual perception, facial and speech recognition, language translation, learning and planning for problem-solving and decision-making. It uses ML, big data, deep learning, and natural language processing (NLP) for predictive modeling, scenario generation and historical analysis of data.

The machinery, equipment and agents that are AI-enabled can function by acquiring human intelligence abilities. From stock trading, medical diagnosis and autonomous vehicles to personal assistants like Alexa and

*AI is the next big thing in supply chain management. Demand for accuracy, efficiency, time and cost savings in supply chains is driving the market for AI and allied technologies.*

Siri to humanoids like Sophia, AI is transforming the way we live, interact and carry out our social and business activities. Its impact would perhaps exceed that of many other technologies that have so far enriched our livelihoods.

AI has innumerable industrial and supply chain applications. The latter has the potential to operate without much human intervention or supervision. According to McKinsey estimates<sup>16</sup>, supply chains are expected to derive trillions of dollars annually by using AI applications.

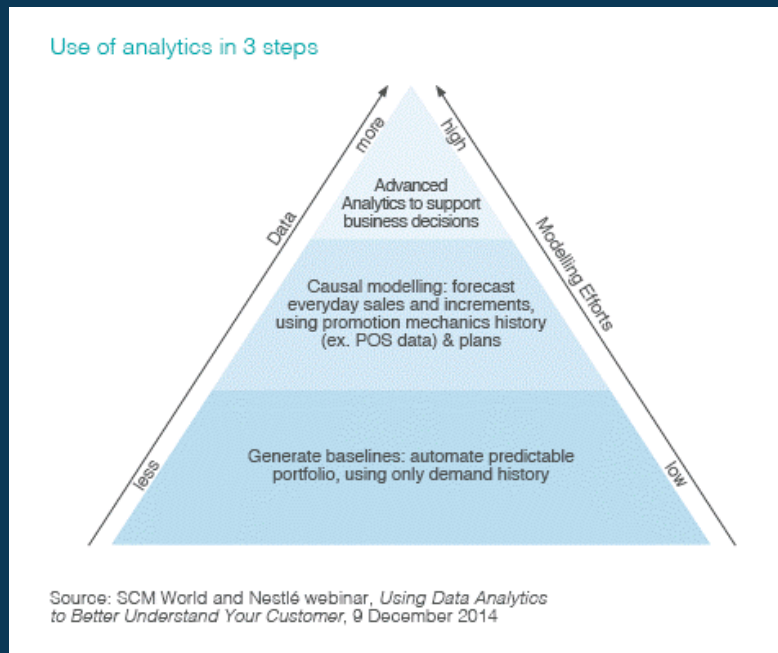
### II. AI in Supply-Chain Management: Potential and Scope

In today's fast-paced world, consumer-driven supply-chains are leading the competitiveness drive. Presently, there are around 30 billion devices in the supply chain capturing data ranging from consumer behavior, supplier operations, manufacturing to distribution, point of sales and returns management.

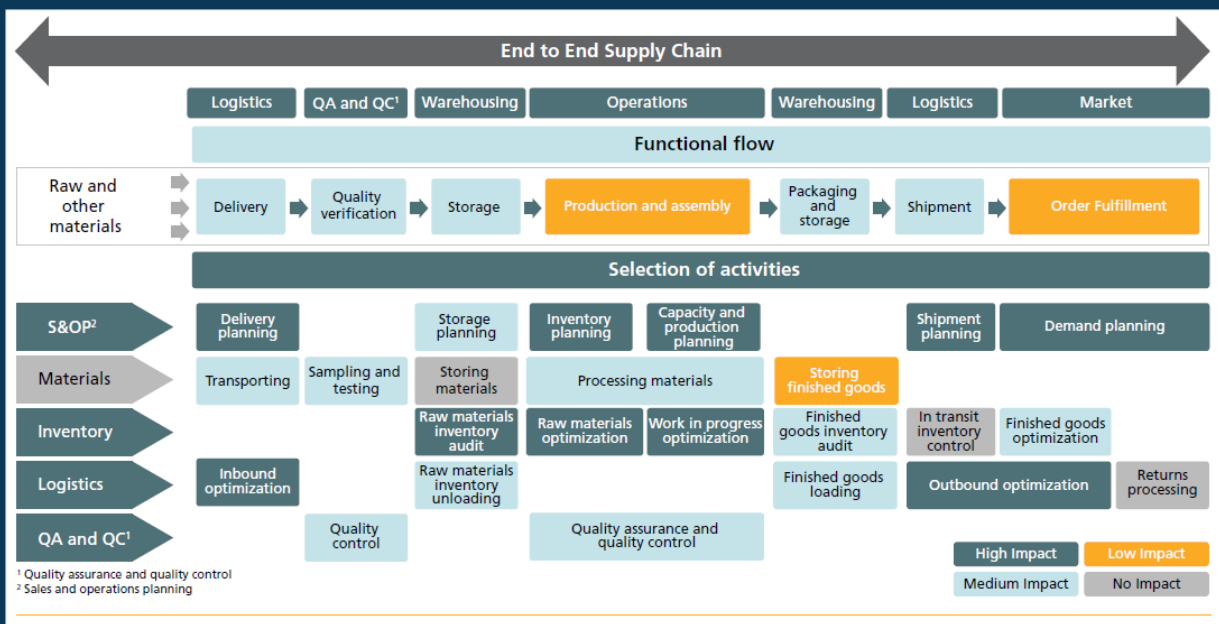
<sup>15</sup> **Dr. Samir K. Srivastava** is Professor and Dean of Research at IIM, Lucknow.

<sup>16</sup> Chui, M., N., Henke & M., Miremadi (2019). 'Most of AI's business uses will be in two areas.' McKinsey Analytics, McKinsey & Company.

Supply-chain management (SCM) systems in the industry use data analytics at 3 levels: generate baselines, causal modeling and advanced analytics.



The entire scope application of AI in the end-to-end forward supply chain process is explained in figure 2



AI has the potential to help supply chains in organizing and analyzing data, which could help in decision making for problems ranging right from customer need analysis, forecasting, placing orders, warehousing, logistics and finally the last mile connectivity.

Endless possibilities exist for learning from nearly 3 quintillion bytes of data generated daily. AI-enabled applications in supply chains are expected to analyze this data, gain a better understanding of the variables to help them in improving efficiency and agility.



As a result, supply-chains of many manufacturing and service industries are adopting AI technologies quite rapidly as a part of their digitization strategies. AI support applications are quite popularly being used in back-end supply chain management of many firms and industries. For instance, the logistics company DHL uses autonomous forklifts in warehouse operations. Telecom manufacturer Infinera used ML to analyze production as well as logistics for better quality delivery. The AI algorithm is used to generate information for sales associates and customers to make them aware of the available products. AI also combines historical data with customer feedback and other reports about weather and logistics to predict the availability of products in the hands of the customers. Similarly, Marble gets medicines and packages delivered with the help of robots (that uses LIDAR technology for navigation purposes). Engineering company Rolls Royce makes extensive use of AI technology in cargo transportation. AI is also gaining a lot of traction in the start-up industry.

In a nutshell, AI has the potential to offer a significant edge to the entire supply-chain network by predicting future trends, risks, and even leading to the creation of creative servicing designs. For instance, in the field of the automobile sector, vehicle to vehicle (V2V) contact combined with AI could reduce the number of accidents on roads by proactively alerting them. In procurement, AI's contribution in various analyses (like spend analysis, cost analysis, supply source analysis, smart contracts, etc) may help in

improving productivity. Similarly, AI could also be used in predicting future uncertainties and preventing potentially corrupt or negligent acts in supply-chain management practices.

A growing amount of literature is also focusing on the importance and potential of Green Supply Chain Management (GrSCM). Adding the 'green' component to SCM essentially involves addressing the influences and relationships between SCM and the natural environment. In other words, GrSCM is primarily defined as 'integrating environmental thinking into SCM, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers as well as end-of-life management of the product after its useful life' (Srivastava, 2007)<sup>17</sup>. Studies on GrSCM have reinforced that investment in such an emerging research field could be resource-saving, productivity-enhancing and waste-reducing.

#### *Associated Challenges*

There do exist few challenges in the application of AI in supply chains. All computational processes need good and accurate data; AI is no exception. AI systems must have access to a huge range of data to train and build the appropriate knowledge base for the smooth functioning of an end-to-end supply-chain management system. ML, in particular, requires huge volumes of accurate data to train algorithms and develop predictive models.

<sup>17</sup> Srivastava, S.K. (2007), 'Green supply-chain management: A state-of-the-art literature review'. International Journal of Management Reviews. Vol. 9, Issue 1, pp. 53-80.

However, existing supply-chains are inherently cross-functional and cross-enterprise and the data needed to operate them is scattered among various partners. Most supply-chains today neither have the requisite quality nor quantity of data and seamless information sharing features. Consequently, an exhaustive, robust and accurate series of datasets with advanced analytical capabilities is a pre-requisite to leverage AI for the effective operation of the supply-chain system. Without access to all such relevant data, algorithms will have blind spots and will often miss opportunities for optimization and execution.

It has also been noticed that the use of predictive AI analytics in adoption is lagging. According to an industry survey, only 12 percent of AI is being used in companies for predictive analytics to the tune of 28 percent. If the adequate infrastructure is provided backed with sound policies, it is projected that over 60 percent of AI could be deployed for predictive analytics (over 80 percent) in the next 5 years.

Moreover, as far as GrSCM is concerned, one of the biggest challenges which exist for researchers and policy experts in capitalizing on the benefits of it is the inherent complexity of environmental issues – such as the existence of multiple stakeholders and the uncertain implications underlying the growing international competition of this field. Moreover, the conventional ideology of segregating or buffering the operational aspect of SCM from external influences

such as the natural environment to improve efficiencies, quality and maintain cost-effectiveness, restricts the usage of GrSCM for practical purposes (Srivastava, 2007)<sup>18</sup>

### III. Conclusion: The Way Forward

In the longer run, mankind faces the dilemma that whether one should allow the supply-chain management system to operate automatically based on the decisions of autonomous agents or allow human intervention; especially in areas where it is not clear as to how AI arrived at such decisions

#### Dilemma:

AI + IOT+ Blockchain ≠ Autonomous Supply Chain System

Stakeholders must know how AI algorithms work, how they are combined to arrive at decisions and how they create and distribute value across supply chain partners. Ideally, AI should be able to provide an explicit reason behind the decision so that it can be easily understood. Moreover, ways could be devised to evaluate and scrutinize the decisions of autonomous agents. The need of the hour is to also have an effective national approach and policy legislation for data sharing across the supply chain network to ensure its smooth functioning.

*This chapter has been evolved from a talk and based on the inputs of an eminent academic expert, Prof. Samir K. Srivastava who was invited to give a talk at the AI webinar. The title of his talk was 'AI in Supply Chains'.*

<sup>18</sup> Ibid

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tats { display: none; }

ticky {
margin-bottom: 50px;

ticky .content-inner {
margin-bottom: 0px!important;
padding-bottom: 0px!important;
border-bottom: 0px!important;
-o-box-shadow: 0 1px 2px rgba(0,0,0,0.2);
-moz-box-shadow: 0 1px 2px rgba(0,0,0,0.2);
-webkit-box-shadow: 0 1px 2px rgba(0,0,0,0.2);
}
```

## CHAPTER 6.

### POLICY FRAMEWORK TO CATALYZE AI-CENTRIC TECHNOLOGY ECOSYSTEM IN INDIA

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margin-bottom: 10px;
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background-color: #E6E6E6;
text-align: center;
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.side-box a:visited {
font-weight: normal;
color: #06c55b;
font-size: 12px;
```

## CHAPTER 6

# ENABLING A \$5 TRILLION INDIAN ECONOMY: A POLICY FRAMEWORK TO CATALYZE AI-CENTRIC TECHNOLOGY ECOSYSTEM

*Anjali Taneja and Ravi Kothari*<sup>19</sup>

*The classical approach in establishing a system based on first principles (or rules) has been eclipsed by a newer paradigm in which a system is constructed based on examples. This newer paradigm, the basis of contemporary AI, allows the creation of complex systems that were impossible to create a few years ago. Not surprisingly, this newer paradigm has rapidly been adopted in diverse disciplines for discovering, modelling, and inferring from data. Besides the growing excitement associated with its potential to catalyze discoveries, it also has the potential to have a profound business and economic impact. With India aspiring to become a US\$5 trillion economy in the coming years, it is essential to evaluate the role that AI can play in helping achieve that goal. This chapter examines the potential of AI in promoting economic growth and policies that may amplify the efficacy of AI in helping India achieve its growth aspirations.*

### I. Introduction

John McCarthy, popularly known as the father of AI, described it as the “science and engineering of making intelligent machines, especially intelligent programs”. McCarthy’s notion set the stage for technocrats, policy analysts and thought leaders to advance research, policy dialogues, and deliberations

related to AI. Such discussions have been steadily gathering momentum with the increasing realization of the significant impact that AI has on employment generation, research and innovation and quality of life

India is exploring AI as one of the key enablers of its vision of becoming a US\$ 5 trillion economy. Introducing the theme #AIforAll in 2018, India seeks to enhance the deployment of AI in growth-oriented sectors of the economy. Budgetary outlays and considerable focus on investment in AI, data analytics and ML have been laid in the annual Union Budgets of recent years. It is thus an appropriate time for India to formulate a national policy framework governing AI so that it could appropriately leverage and promote the technology to realize rich socio-economic dividends.

This chapter underscores the need for a focused national policy on AI in India to enable its effective contribution to technology oriented-economic development.

### II. Literature Review

Though it is possible to specify a set of rules and induce a machine that can play a game of tic-tac-toe, it is impossible to specify rules as the complexity of the task increases. For

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example, imagine writing a set of rules for a self-driving car. Contemporary machine learning is thus largely based on “learning from examples” in which a machine is induced from data as opposed to being constructed from first principles or domain-specific rules. An impressive array of applications have already been demonstrated using this paradigm of “learning from examples” -- self-driven automobiles, clinical decision making, online chatbots, the design of new drugs, autonomous legal aids and robotic chefs to name a few. What is even more promising is that the systems constructed using this paradigm, in most cases, can out-perform existing state-of-the-art systems.

Not surprisingly then, AI has become central to various imperatives as nations seek to leverage it in boosting their economic output as well as improving the overall quality of life of its citizenry. In the next two sub-sections, we provide a concise summary of the expected impact of AI deployment and the sectors intended to benefit from it.

### ***Across the globe***

Multiple studies have estimated the economic gains from the deployment of AI. For instance, according to Bughin and Zeebroek (2018), AI contains the potential to bolster “additional global economic activity of around US\$13 trillion by the year 2030”, which could, in turn boost the global GDP by almost 1.2 percent per year. Similarly, Ghosh (2017) reports AI’s contribution to the tune of US\$ 15.7 trillion in the global economy by 2030. Moreover, it is estimated that over the years, the world could also witness significant labor productivity improvements and improved

consumerism resulting from AI-driven product enhancements.

Liu (2020) highlights the surging revenues from an AI-driven software market. They have risen from a little over US\$ 10 billion in 2018 to nearly 15 billion last year and which could further touch to US\$ 126 billion by 2025. Aron and Sicular (2019) emphasize the enhancements in business values and productivity of workers as a result of AI. They say, “AI augmentation will create US\$ 2.9 trillion worth of business value by the year 2021 and 6.2 billion hours of workers “productivity globally”.

The literature also confirms the positive impact of technological advancement through AI on employment generation. The introduction of robotics and advanced machine learning techniques are expected to significantly open the job market (De Backer et al. 2018; Bessen, 2017b; Graetz and Michaels, 2018). According to Ernst, et.al. (2018), it is a universal phenomenon. Referring to the industrial revolution of the 19th and 20th centuries, they underline the fact that the wave of automation during that period led to an increase in demand for labor, primarily in technology-driven sectors such as manufacturing, mining, and construction. Malik et.al. (2018) has reported that AI augmentation could generate almost US\$ 2.9 trillion in business value by the beginning of the year 2020, and the employment generation to the tune of almost 2 million by 2025. Gill (2018) underscores the interest stimulation among people generated from AI, deep learning and machine learning tools, in entrepreneurship for areas ranging from healthcare and medicine to Industry 4.0 projects.

A parallel argument in literature states that modernization in technologies is also causing widespread job displacements, job polarization, widening income gaps and inequalities (Korinek and Stiglitz, 2017; Méda, 2016). However, another set of studies also reveal that such displacements are counterbalanced by widespread job opportunities and skills development needs. For example, the study undertaken by Malik et.al (2018), estimated that that 1.8 million jobs are expected to be eliminated by 2020 worldwide, but at the same time, another 2.3 million new jobs will also be created by then, as a result of AI.

### *The India story*

In India, the growth of AI is expected to take the path of an S-Curve which depicts a slow start at the beginning and subsequent acceleration in the deployment of AI with increasing competition, leading to improvement in complementary capabilities.

AI has significant potential to value add and infuse growth in the Indian economy. According to Menon, et.al. (2017), AI is estimated to perhaps add 15 percent of the current GVA to India's GDP, which is almost US\$ 957 billion, by the year 2035. Breaking this figure down, the authors have estimated that almost US\$ 597 billion of the GDP is expected to be generated through AI-driven augmentation in factor inputs, another US\$ 277 billion through AI-facilitated productivity enhancement and the remaining through intelligent automation. This means that it could boost India's annual growth by nearly 1.3 percentage points each year, leading to an additional US\$ 1 trillion being infused

into the economy over the years. This is quite a significant contribution to growth, in comparison to some of India's peers.

Studies and reports have also highlighted the nation-wide benefits of AI in terms of massive job creation, up-skilling and reskilling of the workforce and significant improvement in productivity in demand generating sectors. According to one such study from Malik, et.al. (2018), AI and ML are expected to absorb almost 9 percent of India's workforce in new employments. Moreover, Information Technology – Business Process Management is expected to be the highest employment generating vertical in India followed by infrastructure development, healthcare and manufacturing. Additionally, around 37 percent is expected to take-up in jobs requiring radically changed skill sets with the diffusion of AI.

In the case of agriculture, the sector contributes nearly US\$ 540 billion and employs over 50 percent of India's working-age population, there is ample evidence that technology intervention can lead to significant sustainable agrarian development in India (Kundu, et.al, 2020). Specifically, AI can be quite beneficial in improving the farmers' incomes. According to Menon, et.al. (2017), the earnings of Indian farmers can rise by almost US\$ 9 billion because of AI. Similarly, for MSMEs that account for 30 percent of the country's GDP, AI-augmented interfaces intertwined with users' segmentation and predictive analysis can enhance and improve user engagements, over the years.

### III. Policy Framework: Way Forward

#### *Reality Checks*

AI is expected to transform India's economic landscape from agriculture to manufacturing and services. It is thus an opportune time to devise a strategic plan and formulate a national policy framework on AI to enable, and perhaps even, catalyze the transformation. This would entail a closer examination of the existing challenges in the smooth diffusion of AI.

As mentioned before, the GoI initiated a discussion paper on AI in 2018. According to Niti Aayog (2018), the overarching theme *#AIforAll* aims at enhancing and empowering human capabilities to address the challenges of access, affordability, shortage, and inconsistency of skilled expertise; implementation of AI initiatives to evolve scalable solutions for emerging economies; tackling application, research, development, and technology-based challenges; and enabling collaborations and partnerships for greater good and prosperity.

However, there lay some underlining challenges in its deployment. These include the lack of broad-based expertise in AI research and applications, absence of enabling ecosystems – access to intelligent data, high resource cost, low awareness on AI adoption, privacy and security issues, lack of formal regulations around data flow and reliability and absence of collaborative approach on adoption and application of AI (Niti Aayog, 2018).

The authors have delineated these challenges in the Indian context against some of

the defining benchmarks of AI which are standardization; knowledge transfer; ethics, accountability, traceability, certification; research, innovation and entrepreneurship.

#### *Challenges*

1. **Standardization:** Standards are the basis for the industrial-scale use of AI. They pertain to the entire AI pipeline – from data to model creation, model validation, interoperability to deployment and commerce. According to Marr (2017), while standards are required for each component of the pipeline, nothing is more crippling than the non-availability of data that can be used to train AI models. The GoI has also reinforced the need for data availability with adequate safeguard mechanisms in place for the effective deployment of AI systems.

The challenge lies in the lack of appropriate and effective standardization policies in place. 'The most important challenge in India is to collect, validate, standardize, correlate, archive and distribute AI-relevant data and making it accessible to organizations, people and systems without compromising privacy and ethics... ensuring data security, protection, privacy, and ethical use via enabling framework, both regulatory and technological' (GoI, 2018). Therefore, standardization is the key to the functionality and interoperability of AI platforms.

Some of the existing global initiatives in this area are noteworthy and worth studying while formulating a national plan of action on AI in India. For instance, according

to a report of Tsinghua University (2018), China has underlined its standards and guidelines on AI under the 'New Generation Artificial Intelligence Development Plan' in the year 2017. Also, its 2018 white paper on AI highlighted the country's domestic standardization policy framework to set up an AI industry worth US\$ 140 billion. Similarly, the USA's American AI Initiative released a comprehensive plan on federal engagement in developing technical standards and related tools on AI, in the year 2019 (Federal Government of the USA, 2019).

**2 Knowledge transfer:** Transfer of knowledge and its management is essential for an effective understanding of AI. The literature has consistently emphasized the need to bridge the gap between ML and human learning through such information exchanges. Foreexample, Torrey and Shavlik (2009) highlighted the techniques that enable knowledge transfer to represent progress towards making machine learning as efficient as human learning.

In India, the technical expertise needed for the deployment of AI has been found out to be insufficient due to the limited training facilities and inadequate efforts in capacity building of the workforce. While digital and open learning platforms are promoted to enhance capacity building and public awareness on AI and the IoT, the access, quality and authenticity of such online avenues remain a concern. Therefore, streamlining measures to promote their uniformity, standards, and outreach especially in remote areas, are

needed. For instance, in the agriculture sector, the development of smart weather pattern tracking applications could be beneficial for the yield and production of crops. In such a case, the users and providers should have adequate access to IoT devices and appropriate knowledge of their functioning so that such an application can be beneficial in making correct predictions of the weather.

Various studies have also emphasized the skilling and reskilling component of the workforce. That is an important ingredient for India to ensure continuous absorption in AI deployed priority sectors. Therefore, specialized courses and academia-industry driven curriculum on AI, are the need of the hour. The integration of AI-centric skills with the existing standards of the National Skill Qualification Framework (NSQF) is also crucial to mitigate the demand and supply of skills mismatches in this field and improve domestic employment or job creation in the country.

**3 Ethics, Accountability, Traceability and Certification:** The effective deployment of AI underlines the need for transparency in the flow of information, data and algorithmic programming, data privacy, certification of the technology and traceability and accountability of users and owners. In other words, AI is governed by certain strict ethics concerning its use.

In India, the issues of privacy and transparency of data, its storage and dissemination need to be properly addressed. The country needs an effective regulatory framework governing



the collection, dissemination and use of data. The digital flow of information also carries the risk of security breaches and cybercrimes in the absence of adherence guidelines and an approved code of conduct. Therefore, the need of the hour is to have in place a robust AI ecosystem in India supported by an appropriate indigenous infrastructure for data storage and processing. At the same time, the local institutions can also upgrade their technology networks to optimize economies of scale. In other words, scalability must be undertaken on a high priority to ensure the enforcement of security-driven last-mile data connectivity.

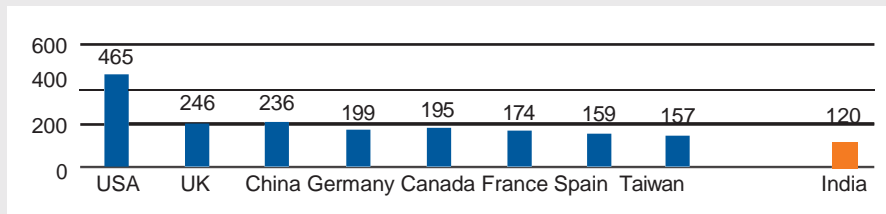
The GoI has proposed the setting up of a 'consortium of Ethics Councils' which would design guidelines on privacy, security, and ethics of AI. This would ultimately lead to the creation of a National AI Marketplace that would encourage discovery, innovation and reduce the time and cost involved in data collection.

**4. Research, education, innovation, and entrepreneurship:** The emerging technology frontiers of AI invite advanced research and innovation on one hand and a thriving start-up industry on the other. The former refers to the provision of higher education centered on advanced AI learnings including applied algorithmic programming, digital ledger technology, data analytics, cyber-infrastructure, etc. It would also include interdisciplinary research in AI and investment-driven focused research and development (R&D) projects.

The global initiatives in this field are worth emulating. For instance, countries like the USA and South Korea have targeted huge investments in AI-driven R&D. The former also has a national AI R&D Strategic Plan in place examining the critical areas of R&D that require government investments. Similarly, some of the UK's private universities like Cambridge and Oxford are popularly known as centers of AI innovation, stimulating start-ups in this field. Its Alan Turing Institute or the National AI Centre (the national institute for data science) encourages interdisciplinary solutions to real-world problems (Saran et.al. 2018). Similarly, in China, according to Robbins (2019), higher education universities have been receiving funding from their government to establish a dedicated Research School on AI within their campuses. Interestingly, the country has also partnered with various information technology companies to promote field-specific research and industrial leadership. Moreover, a technology park worth US\$ 2.1 billion has also been set up in Beijing to facilitate AI-driven research.

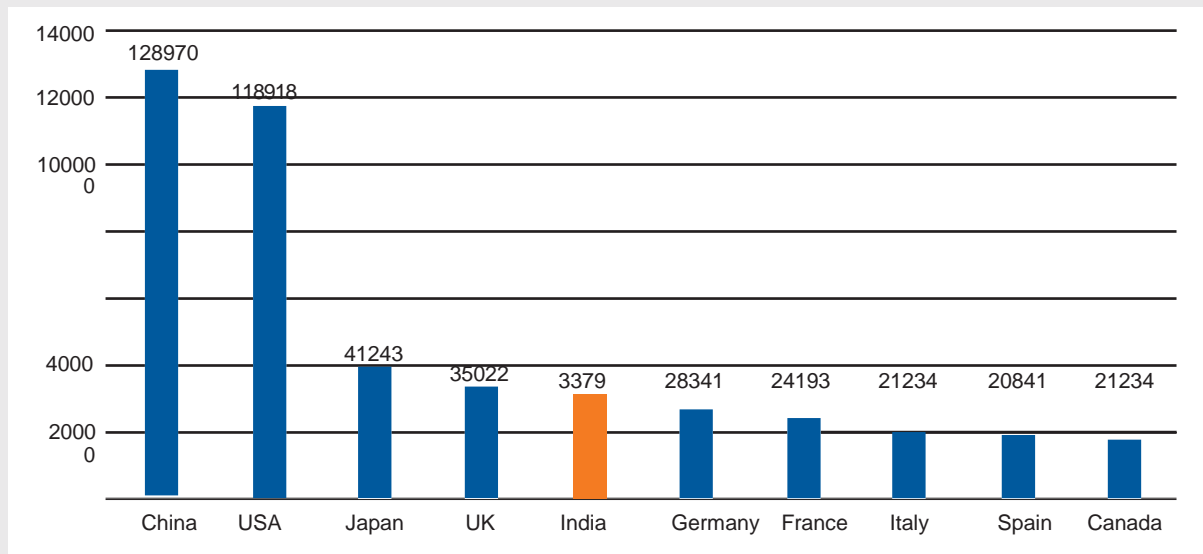
In India, on the contrary, AI-oriented research is still catching up and needs to be heavily invested in. Existing data reveals that research and innovation in the field are far below the existing potential the country has in the background of positive macro-economic fundamentals and a thriving technology market. Figures 1 and 2 reveal some of the statistics. According to the H-index (**Figure 1**), India has been globally ranked at the 17th position. Similarly, for the number of AI-centric research publications or citable

**Figure 1: H – Index for AI (1996 – 2018)**



**Source:** Scimago Journal and Country Rank (SJR) Country Rankings 2020

**Figure 2: Citable Documents in AI (1996 – 2018)**



**Source:** Scimago Journal and Country Rank (SJR) Country Rankings 2020

research documents in AI, India is ranked behind China, the USA, Japan and the UK (figure 2).

The Gol has also flagged the limited academic research work being carried out in this field in the country. According to the Gol (2018), out of the 22,000 global doctorate scholars on AI, approximately 386 are in India. This is minuscule considering India's growing percentage of human capital, primarily youth. Additionally, it has also been reported that quality research work on AI is estimated to be among less than 50 researchers in the country primarily concentrated at national technology and science institutes.

One of the underlying reasons for such a non-satisfactory research performance lies is because of inadequate academia-government-industry collaborations. The lack of such engagements and partnerships restricts the growth of research, innovation, and entrepreneurship in the country. The Gol (2018) has also reinforced the need for an active engagement of all stakeholders to enable consensus-driven decisions. It is, therefore, imperative to leverage the unique and vibrant R&D ecosystem of India combining the strengths of government, academia, and the industry.

Another reason lies in the fact that India's

tertiary education in AI is in the nascent stages. Education and technological inclusion of individuals in a country are closely interconnected. According to Guilherme (2019), education allows individuals to become technologically included in a particular country, thereby becoming fit to join the labor market and contribute to its economic development. Therefore, the higher education universities and institutes of India must gear up to ensure that the learnings in AI are progressive, inclusive, skills-oriented and employment generating.

There is a need to formulate a skills-oriented curriculum for higher learnings and specialization. Up-skilling and re-skilling of the workforce and university students can be undertaken through various training programs like the national mentoring program, decentralized content generation mechanisms and community-based learning models. Laboratories in AI, ML and Computational Thinking at universities can actively contribute towards capacity building, strengthening computational skills and predictive capabilities of students.

Finally, from a regulatory angle, research-driven innovation and activities must be streamlined with the help of a 'regulatory sandbox' environment and a robust intellectual property framework. As a success story, the former is already being implemented by the Government of Japan, where-in the country has AI

Centric regulatory sandboxes providing certification and testing spaces for innovative AI solutions and curation of data (Saran et.al. 2018).

In the case of the latter, the establishment of Intellectual Property Centres may perhaps bridge the existing gaps between AI developers, programmers, practitioners and policymakers. The narrow-focused and stringent patent law regime could be replaced with a more innovation-friendly IP law. Simultaneously, regulatory incentives especially to promote the growth of start-ups and MSMEs in this field, would be quite beneficial.

In other words, a robust policy regime that encourages quality research, new inventions and innovations as well as nurture entrepreneurial talent, is the need of the hour.

In a nutshell, the *matrix* below lists out the desired actions against each of the AI benchmarks specified above. There is a considerable amount of good work that is ongoing in India and we present the suggestions in the matrix to augment these efforts.



**Matrix:** A summary of necessary steps or measures which could be undertaken

Benchmarks	Suggestive Measures to promote and realize the benefits of AI
Standardization	White Paper on AI standards and guidelines underlining standardized laws and regulations on AI; regulatory framework governing technical standards on AI; building a secure data ecosystem with the help of a national law/legislation governing data usage, privacy, protection and security and inoperability of AI platform
Knowledge transfer	Policy guidelines underlining authenticity of content and services offered through online and open-source learning platforms; collaborative initiatives to enable creation and outreach of AI-driven applications, IoT in remotely accessible areas; Integration of skill requirements/demand with the supply of training sessions through NSQF; Provision of training, specialized courses through academia-industry linkages/collaborations; focused public discourses and deliberations to spread knowledge awareness on AI.
Ethics, accountability, traceability, certification	Ethics Councils, Facilitation of data processing and storage architecture at a national scale through suitable funding model / PPP, certification authority to certify AI implementations and promote confidence and experimental modelling.
Research, innovation, and entrepreneurship	Strategic Plans on R&D funding; Specialised Research Centres on AI / Centres of Research Excellence / Think Tanks focusing on core technology research of AI at universities (provision of funding and specific grants to support such initiatives); academia-government-industry collaborations or partnership initiatives; active engagement and involvement of all stakeholders from the academic community and industry in the policy formulation process. Regulatory / innovation sandboxes, Centres of AI Innovation at universities, IP facilitation Centres. PPP entrepreneurship learning platforms; regulatory incentives, investor-friendly policies encouraging the growth of start-ups and SMEs; industry-driven incubation facilities on AI for startups to encourage entrepreneurship.

Education	Specialized courses (such as credit-bearing open online courses) and certifications on AI for students; academia-industry collaboration driven curriculum design for better employment opportunities; skills development and training facilitation to faculty and graduate students on use-based AI programs; institutionalization of special fellowships on AI to promote advanced education and research; formation of a global expert pool for core research on AI-supported by special financial grants and subsidies; university-industry partnership-driven Centres of Transformational AI in sectors like health, education, agriculture, smart mobility, etc.
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### *Policy Framework*

The previous section highlights the challenges and the possible measures to ensure the effective contribution of AI in India's growth and development. This must be governed by a national policy framework. The Policy must be holistic and supported by a visionary roadmap for its implementation. Such a policy framework should be able to examine the issues, challenges and delineate doable measures to resolve them. This could ensure the effective and seamless deployment of AI across different verticals and streams.

#### **The guiding principles for a comprehensive policy framework on AI are the following:**

- a) AI should benefit people by driving inclusive growth, sustainable development, and well-being.
- b) AI systems should be designed in a way that respects the rule of law, human rights, democratic values, and diversity, and they should include appropriate safeguards – for example, enabling human intervention where necessary.

- c) There should be transparency and responsible disclosure around such systems to ensure that people understand AI-based outcomes, can audit them, and if required, challenge them.
- d) AI systems must function in a robust, secure and safe way throughout their life cycles and potential risks should be continually assessed and managed.
- e) AI systems should be certifiable in the same way that many other systems are certified (for example, setting up of certification institutions for like on the lines of ISI).

#### **IV. Conclusion**

AI has immense potential to spearhead a technology revolution world-wide. Recognizing the positive potential benefits of an AI-economy, several countries like the USA, Japan, the European Union (EU), South Korea, the UK, etc have executed national strategies, plans, and focused policies to facilitate AI's smooth deployment and application in their respective economies.

It is an apt time for India to leverage this potential and bridge the gap between human learning and AI. As the Hon'ble Prime Minister of India has cited, "There should not be a debate on the dangers of artificial intelligence, but there should be a debate as to when the robot will be smarter than the human. There should be a debate as to how a bridge can be made between artificial intelligence and human intentions." A beginning has already been made in this direction with India becoming a founding member of GPAI.

The need of the hour is to have in place a robust national policy on AI and a visionary roadmap for its timely implementation. This must include the scope of collaborative initiatives between the academia-industry and academia – government; interdisciplinary studies; measures to empower human capital to address the challenges of accessibility, affordability, and quality of the skilled workforce; regulatory incentives and sustained funding mechanisms to encourage research, innovation, entrepreneurship and quality of life in the country.







**CHAPTER 7.**  
**CONCLUSION**



# CHAPTER 7

## CONCLUSION

AI is transforming the global technological landscape with socio-economic implications on economies worldwide. Effective deployment of AI under a streamlined policy framework could contribute towards economic growth, innovation and development. In India, it holds significant scientific and economic potential. With the nation striving to become a US\$5 trillion economy in the coming years, AI could perhaps be the next generation technology tool to achieve the target.

COVID-19 has exposed the vulnerabilities of the economy in healthcare, predictive analysis to foresee future uncertainties, data storage and security. AI can play a significant role in bridging the existing gaps, overcoming such vulnerabilities and enhancing learning outcomes through AI-enabled targeted intervention. It then becomes imperative for India to leverage the potential of AI effectively as well as efficiently and realize rich dividends.

In this concluding chapter, we summarize the key findings and suggestions that could be useful in formulating suitable policies on AI for its effective deployment in India.

**1. From investment to implementation:** It is time to shift resources from the 'age of formulation' to the 'age of implementation'. In other words, it is imperative to implement the national strategies, approaches and plans formulated on AI since 2017. Besides the investment in AI which is being given a significant boost, start-ups in this field must be encouraged to scale up, the issues of connectivity across shared infrastructure or platforms must be sorted and a target-driven implementation mechanism could be put in place that is governed by a streamlined regulatory framework.

**2. Boost to R&D, talent and education:** The need of the hour is the development of a robust AI-driven research and innovation system PAN-India through the integration of core and applied research in AI and academia-industry-government collaborations. The education institutions could be encouraged to enhance the provision of (Science, Technology, Engineering, Mathematics) STEM courses in schools, reform curriculum and enable the provision of purpose-driven AI degrees in colleges and universities besides encouraging training and workshops on AI by the industry.

Quality research in the field of AI could foster breakthroughs, protection of intellectual property and reskilling of the talent pool. This could be strengthened by setting up research centers at the universities in collaboration with industry

or the government. The 'triple helix' model could be an effective strategy to combine the efforts of academia, government and industry. Besides, international collaborations with other countries in the field of research and output on AI must also be actively explored.

### **3 Enhance deployment in demand-generating sectors:**

The dependency of a large percentage of the workforce on the agriculture sector of the economy for employment and revenue generation, makes the sector one of the demanding fields in the country. It is therefore essential to ensure effective deployment of AI in the sector not only to increase yield but also to enhance the quality of yield or produce and for better supply-chain management. This could help India to maintain a competitive edge in the sector globally and could also help the farmers join the global value chain for better returns.

### **4 Enablement of a concrete governance structure for AI:**

The effective deployment of AI calls for a governance mechanism in place which is streamlined with a clear allocation of responsibilities and roadmap for research, industrial expansion in the field as well as achievable targets and timelines. Besides, suitable legislation or Bill governing data protection, privacy and safety could also be enforced. The issues concerning data quality and fragmentation of data, storage and readability of data must also be addressed through appropriate stakeholder consultations and robust data-usage guidelines.

### **5 Focused promotion and dissemination drive on AI:**

The potential of AI can be effectively harnessed if the states of India are aware or informed of the benefits as well as the associated risks of deployment. Therefore, consultations, workshops, training sessions organized by the state governments on AI at regular intervals, could be beneficial. Academic institutions could partner with the states to facilitate the awareness drive on AI.

Emerging India is uniquely positioned to enable effective deployment of AI for the technological advancement, growth and development of its economy. This could only be a reality if the country can strategically leverage its domestic resources and international relations in the way best possible.







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# ANNEXURE

- PROFILES OF EXPERTS
- WEBINAR ON ARTIFICIAL INTELLIGENCE, JULY 17, 2020:  
*BROCHURE & PROGRAM*

## PROFILES OF EXPERTS



**Dr. Alpan Raval** is the Head of Data Science at the Wadhvani Institute for Artificial Intelligence. He is a theoretical physicist by training, with a broad research background spanning black hole physics and cosmology, computational biology and chemistry, applied mathematics and machine learning. Dr. Raval has taught mathematics and bioinformatics at the Claremont Colleges in California and have worked in computational science and machine learning at D E Shaw Research, Amazon, and LinkedIn. He has co-authored a book on genomics-based network biology: Introduction to Biological Networks.

(<https://www.wadhwaniai.org/team/alpan-raval/>)

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**Dr. Avik Sarkar** is Faculty at Indian School of Business working in areas of Data, Emerging Technology and Public Policy; where he also heads the development of India Data Portal. Dr. Sarkar was the former Head of Data Analytics Cell and OSD at Niti Aayog; has also been involved as an Advisor at various government committees. Presently, he also serves on Academic Advisory Boards of Aegis School of Business and of IIT, Delhi. Dr Sarkar has over 18 years of experience across AI, data science, statistical modelling, text mining, and network analysis in renowned MNCs. He is a multiple TEDx speaker; been nominated among the 'Top 10 Data Scientists in India' (2017) and also as 'LinkedIn Influencer' in the technology space (2015). He has authored several technical publications and technology patents. (<https://in.linkedin.com/in/aviksarkar>)

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**Dr. Sudeshna Sarkar** is Professor in the Department of Computer Science and Engineering (CSE) at IIT, Kharagpur. She is currently the Head of the Centre of Excellence in AI and was formerly HoD of CSE at IIT. Prof. Sarkar is also the Project Director of the Technology Innovation Hub on AI for Interdisciplinary Cyber-physical Systems. Her research interests are in NLP and in AI, ML applications. She has been involved in developing NLP resources and tools for Indian language and working on low resourced NLP tasks and Text Mining, and various AI applications in the domains of education, transportation, e-commerce and climate. Prof. Sarkar is interested in exploring the use of AI to make positive impacts in different domains of society and industry. (<https://cse.iitkgp.ac.in/~sudeshna/>)

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**Dr. Samir K. Srivastava** is a Professor and Dean (Research) at Indian Institute of Management Lucknow, India. He is a Graduate in Electrical Engineering from Institute of Technology, BHU and Fellow of IIM Lucknow. Prof. Srivastava has over three decades of experience in teaching, research, consulting and industry. He has been a Consultant to the World Bank, Tata Motors, Ministry of New and Renewable Energy and Indian Army among others. Prof. Srivastava's name figures among top 2 percent scientists in the world created by US-based Stanford University based on career-long impact. His major areas of interest are operations strategy, public procurement, manufacturing excellence, supply chain innovations, reverse logistics and sustainable supply chains. (<http://www.iiml.ac.in/faculty-data?n=MzU=>)

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# WEBINAR ON AI, JULY 2020 (PROGRAM)



## Workshop Program

9:45 am - 9:55 am	<b>Welcome</b> Prof. L. S. Shashidhara
9:55 am - 10:05 am	<b>Opening Remarks</b> Prof. Ravi Kothari
10:05 am - 10:35 am	<b>Artificial Intelligence and Deep Learning in an Uncertain World</b> Dr. Gautam Shroff SVP and Head, TCS Research
10:35 am - 11:05 am	<b>Knowledge Infused Deep Learning</b> Prof. Partha Pratim Talukdar Associate Professor, Department of CDS, IISc and Founder, KENOME
11:05 am - 11:15 am	<b>Break</b>
11:15 am - 11:45 am	<b>Automatic Essay Grading</b> Prof. Pushpak Bhattacharyya Director, IIT Patna and Professor, Dept. of CSE, IIT Bombay
11:45 am - 12:15 pm	<b>On Building Dependable Machine Learning and Computer Vision Systems</b> Prof. Mayank Vatsa Professor and Swarna Jayanti Fellow, Dept. of CSE, IIT Jodhpur
12:15 pm - 12:45 pm	<b>AI in Healthcare</b> Dr. Taposh Roy Manager, Decision Support (Innovation), Kaiser Permanente
12:45 pm - 1:15 pm	<b>AI for Social Good</b> Dr. Alpan Raval Head of Data Science, Wadhvani Institute of AI
1:15 pm - 1:45 pm	<b>Break/Lunch</b>
1:45 pm - 2:15pm	<b>AI for India and Beyond</b> Dr. Manish Gupta Director, Google Research India & Infosys Foundation Chair Prof. at IIIT Blr
2:15 pm - 2:45 pm	<b>Artificial Intelligence in the Classroom</b> Prof. Sudeshna Sarkar Professor, Dept. of CSE and Head, Centre of Excellence in AI, IIT Kharagpur

# Program

2: 45 pm - 3:15 pm	<b>The Ubiquitous AI in BFSI</b> Prof. V. Ravi Head, Center of Excellence in Analytics & Ph.D. Coordinator, IDRBT-NITW Scheme
3:15 pm - 3:30 pm	<b>Break</b>
3:30 pm : 4:00 pm	<b>AI In Supply Chains</b> Prof. Samir K Srivastava Professor and Dean (Research), IIM Lucknow
4:00 pm - 4:30 pm	<b>Ethical Concerns in Healthcare AI Applications</b> Dr. Avik Sarkar Visiting Professor, ISB; Previously, Head, Data Analytics Cell, NITI Aayog
4:30 pm - 5:00 pm	<b>A Global Comparative of AI Policy and Ecosystem</b> Ms. Madhu Vazirani Principal Director, Accenture Research
5:00 pm - 5:10 pm	<b>Break</b>
5:10 pm - 6:00 pm	<b>Discussion and Closing</b>



# WEBINAR ON AI, JULY 2020 (BROCHURE)



## Artificial Intelligence in India: Enabling a Robust AI-driven Technology Ecosystem A Virtual Workshop Friday, 17<sup>th</sup> July 2020

### INTRODUCTION

Artificial intelligence (AI), propelled by machine learning, computer vision and the Internet of Things, is increasingly emerging as a significant enabling technology. It is widely being deployed across all major sectors such as manufacturing, agriculture, healthcare, retail, banking, financial services, public utilities and also for the purposes of national defense and security. As a result, the market size of AI is growing rapidly over a period of time.



AI is expected to contribute significantly to India's growth, development and employment generation. Data projections are quite positive. AI is estimated to add ~ 1 trillion to the Indian economy by the year 2035. Similarly, it has the potential to absorb over 9 percent of India's workforce in new employments, and could contribute nearly \$9 billion to farmers' incomes.

There have been numerous developments in India in this field - institutionally driven, within business processes as well as among consumer lifestyles. Some notable initiatives include the setting up of an AI Task Force by the Ministry of Commerce and Industry (Government of India), to invigorate the use of AI towards India's economic transformation; a national strategy on AI which revolves around the theme #AIforAll (formally introduced in 2018) as well as considerable budgetary outlays earmarked for this field.

The 2020-21 National Budget has also focused on the growing intent of 'Emerging India' towards investments in AI, data analytics and machine learning as part of a broader technology drive for India's digitization, growth and development. After-all, as India strives to become a \$5 trillion economy over the next few years, AI would play an essential role in the transformation process.

Considering AI's growing scope and relevance in the Indian context, Ashoka University is organizing a *virtual workshop on AI* inviting relevant policy experts and thought leaders specializing in this field. The objective of this unique initiative under the science policy cell is to explore different developmental dimensions associated with AI to enable the creation of a robust and sound AI-enabled technology ecosystem in India. The workshop would also lay the grounds for effective academia-government-industry collaborations and strengthen the process of effective policy advocacy in the field.

### AI WORKSHOP: TRACKS



*AI in Medicine* primarily refers to the use of complex algorithms and software to emulate human cognition in the analysis of complicated medical data. It is widely used in synthesis (such as Cheminformatics wherein new drugs are synthesized using deep learning), clinical diagnosis, treatments and prediction of medical results. AI's first usage dates back to 1972 when an AI prototype program was used for treating blood infections.

*AI in the Education* sector has the potential to transform India's education and research landscape. AI can be used to teach or to adapt teaching and/or content for better absorption. Globally, AI enabled tutoring programs, skills-based curriculum and innovative tools for teaching are being adopted to enable accessible and inclusive education. India has witnessed a surge of interests among students wanting to expand their horizon of learning, knowledge and skills development in AI and ML.



*AI in Finance* transforms the way humans interact with money. AI in the financial industry has the potential to streamline and optimize processes ranging from credit decisions, quantitative trading, resolve provenance and manage financial risk.

AI offers contextual intelligence to *supply chains* which can be used by them to reduce the operating costs, reduce latencies, and manage inventories. AI along with ML can be used to gain of new insights into warehouse, logistics and supply-chain management.



*AI in Policy* is an emerging focus area of policy development in India. From this perspective, the purpose of a policy on AI is three-fold. First, policy makers could explore the possibility of investing in its development; second, adoption of AI to secure it benefits for the economy as a whole; and third, to ensure that AI is used in a fair and transparent manner with unambiguous accountabilities.

*Cere AI*: A focus on algorithms, learning paradigms, validation and to extend AI beyond automation, into areas such as creativity



### PARTICIPATION & LOGISTICS

Speakers in the workshop are by invitation; attendance and participation of a larger audience is welcome and is through self-registration at <https://forms.gle/bv6S7E5vix2uqpMC8>

PROGRAMME  
(to be finalized shortly)

You can reach us at:  
Science Policy Cell,  
Office of Research, Ashoka University,  
Plot #2, Rajiv Gandhi Education City, P.O.Rai, Sonapat,  
Haryana 131 029  
Email:

Prof. Ravi Kothari, Professor & Head of the Department (Computer Science) - [ravikothari@ashoka.edu.in](mailto:ravikothari@ashoka.edu.in)  
Dr. Anjali Taneja, Associate Director (Science Policy Cell, Office of Research) - [anjali.taneja@ashoka.edu.in](mailto:anjali.taneja@ashoka.edu.in)  
Prof. LS. Shashidhara, Professor & Dean (Research) - [dean\\_research@ashoka.edu.in](mailto:dean_research@ashoka.edu.in)



## Science Policy Initiative

Science and Technology are instrumental in enhancing scientific innovation, economic performance and social well-being. Ashoka University has set up a Science Policy Initiative (SPI) in 2019 to frame evidence-based policies for addressing societal problems. The Policy Initiative complements the efforts of the University's Faculty of Sciences and spur innovation as well as enable continuous learning into the knowledge ecosystem. SPI aims to promote data-driven research, policy work and advocacy on India's science, technology and innovation space. It strives to serve as a resource body for the government and industry by conceptualizing and preparing high-quality evidence-based policy briefs, recommendation notes, background papers, presentations and other targeted resources. With the broader agenda of contextualizing and reinforcing the efforts of the scientific community in India, SPI acts as a knowledge hub, encouraging discussions, research and policy formulation on science and technology.

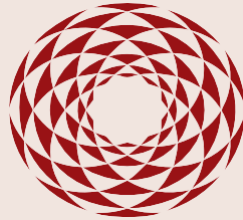
### Science Policy Initiative,

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Ashoka University,

Plot #2, Rajiv Gandhi Education City, P.O.Rai, Sonapat, Haryana - 131 029.

Website: <https://ashoka.edu.in/spiashoka>



**ASHOKA**  
UNIVERSITY

Ashoka University is India's leading Liberal Arts and Sciences University located at Sonapat, Haryana. Ashoka's 2,000-plus students, drawn from 30 states and over 243 cities in India and 27 other countries, receive a world-class interdisciplinary education, led by internationally renowned faculty. The University offers multidisciplinary undergraduate programs that expose students to diverse perspectives, beyond classroom education. Ashoka has also developed eight Centres of Excellence to encourage academic and research collaborations and create societal impact.

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