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Artificial Intelligence and Robotics – 2017

Leveraging artificial intelligence and robotics for sustainable growth

March 2017

ASSOCHAM INDIA

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Message from PwC

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The global scientific community has come a long way since the development of artificial intelligence (AI) as a concept to its modern-day appeal as a field with near-limitless potential in turning around the way activities are performed in a functioning society. The ultimate frontier for AI systems continues to be achieving a level of sophistication that matches that of the human mind.

Researchers and commercial entities are harnessing ways in which AI solutions can make use of the massive data footprint being generated in the process of daily activities through smart technologies such as personal digital assistants, location trackers, sensors, imaging devices and social media feeds.

India has seen a subtle percolation of AI and machine learning into the daily lives of citizens to the extent that the conveniences resulting from their use have become part of our daily reality—for example, customised interactions through a handheld device OS based on user behaviour, app-based cab aggregators, social media recommendations—and no longer seem out of the ordinary. While end users may not be aware that they are using a form of AI, organisations catering to them are identifying different uses of AI to ease delivery of service to end users.

There is a lot of optimism around some of the landmark initiatives in motion, such as Make in India, Skill India, Digital India. At this juncture, it is imperative to gain an insight into the possible implications of AI systems across different application domains.

This is also the best time to moderate the same within the purview of a robust policy framework that serves the dual objectives of technological advancement on the one hand and ethical compliance and social inclusion on the other.

In an ever-evolving and learning AI environment, creating a landscape for institutionalising AI innovation is the need of the hour. This requires close collaboration between academia, the private sector and public sector in order to understand problems holistically and solve them.

India is already on the path of a digital revolution and the next step is utilising the big data generated to take intelligent decisions. Since the effectiveness of AI, machine learning, robotics and cognitive automation increases in direct proportion to a rise in the quality and quantity of training data that the systems are exposed to, the conditions are ripe for India to emerge as a leader in AI.

Through this knowledge paper, we have tried to examine the areas across private and public industries where the AI continuum (augmented, assisted and autonomous intelligence) could be applicable, as well as a robust AI policy framework that needs to touch upon the social, economic and ethical considerations of a well-governed society. These efforts will foster a balanced environment in India for innovation and leadership in AI.

Message from ASSOCHAM

D. S. Rawat
Secretary General,
ASSOCHAM

Since the invention of computers or machines, their capability to perform various tasks has grown exponentially. Humans have developed computer systems by improving their power in terms of diverse working domains, increasing their speed and reducing their size over time.

AI-based applications today have already touched people's lives in many ways. From the intelligent keyboards on smartphones to the voice-activated assistants in tablets and desktops and the devices in a person's immediate personal space—technology has become far more intelligent than it used to be or is perceived to be. Be it financial services, healthcare, education or even security and governance, AI can be exploited for the benefit of citizens and the country. AI-based automation is capable of impacting almost every sector of the economy.

ASSOCHAM believes that national initiatives like Make in India, Skill India and Digital India will immensely benefit from AI technology and suggests that the government should take both long-term and short-term policy initiatives to promote AI in the country.

To understand the impact of AI on various sectors and the various policy initiatives required, ASSOCHAM has organised this conference on Artificial Intelligence and Robotics – 2017.

ASSOCHAM is committed to creating more awareness about the subject and this background paper, jointly prepared by PwC and ASSOCHAM, is a step in that direction. We congratulate the team on their efforts and convey our very best wishes for the success of the conference.


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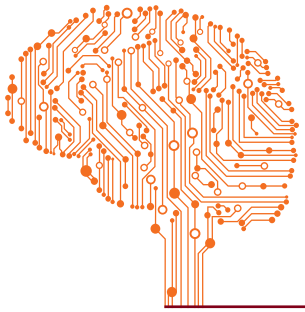
1. Artificial intelligence (AI)

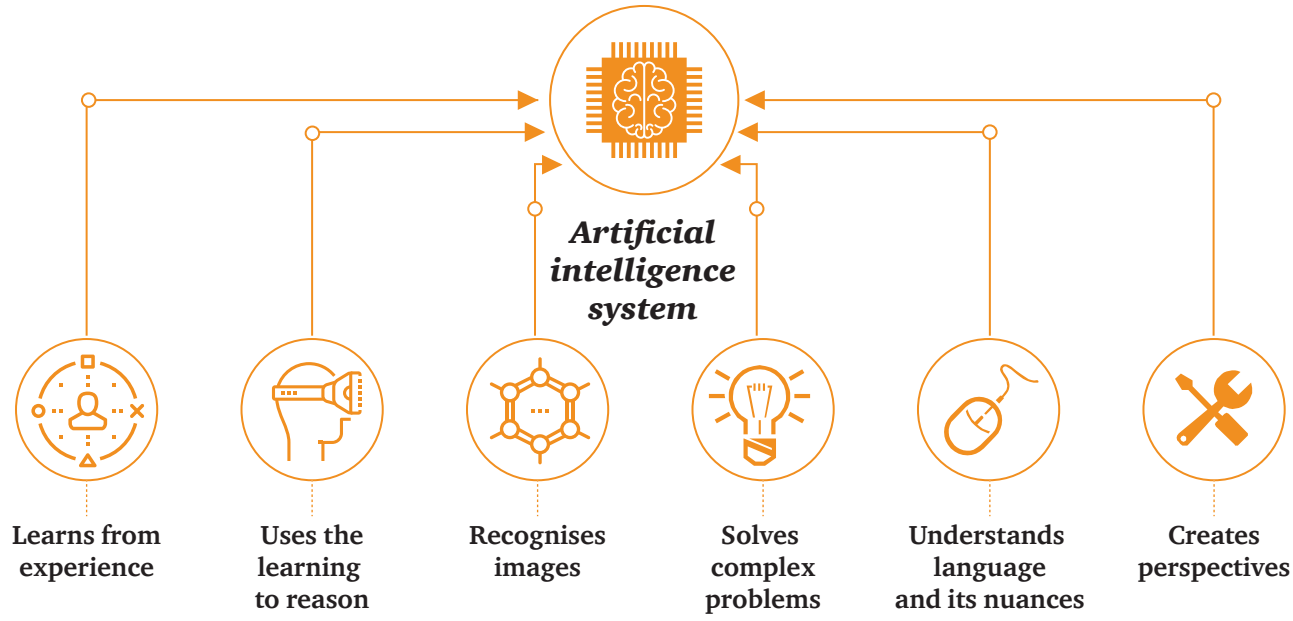
1.1 What is AI?

Artificial intelligence refers to the ability of a computer or a computer-enabled robotic system to process information and produce outcomes in a manner similar to the thought process of humans in learning, decision making and solving problems. By extension, the goal of AI systems is to develop systems capable of tacking complex problems in ways similar to human logic and reasoning.



Artificial Intelligence is the science and engineering of making intelligent machines, especially intelligent computer programs.

- John McCarthy, father of AI



Source: PwC analysis

The AI continuum

Assisted intelligence

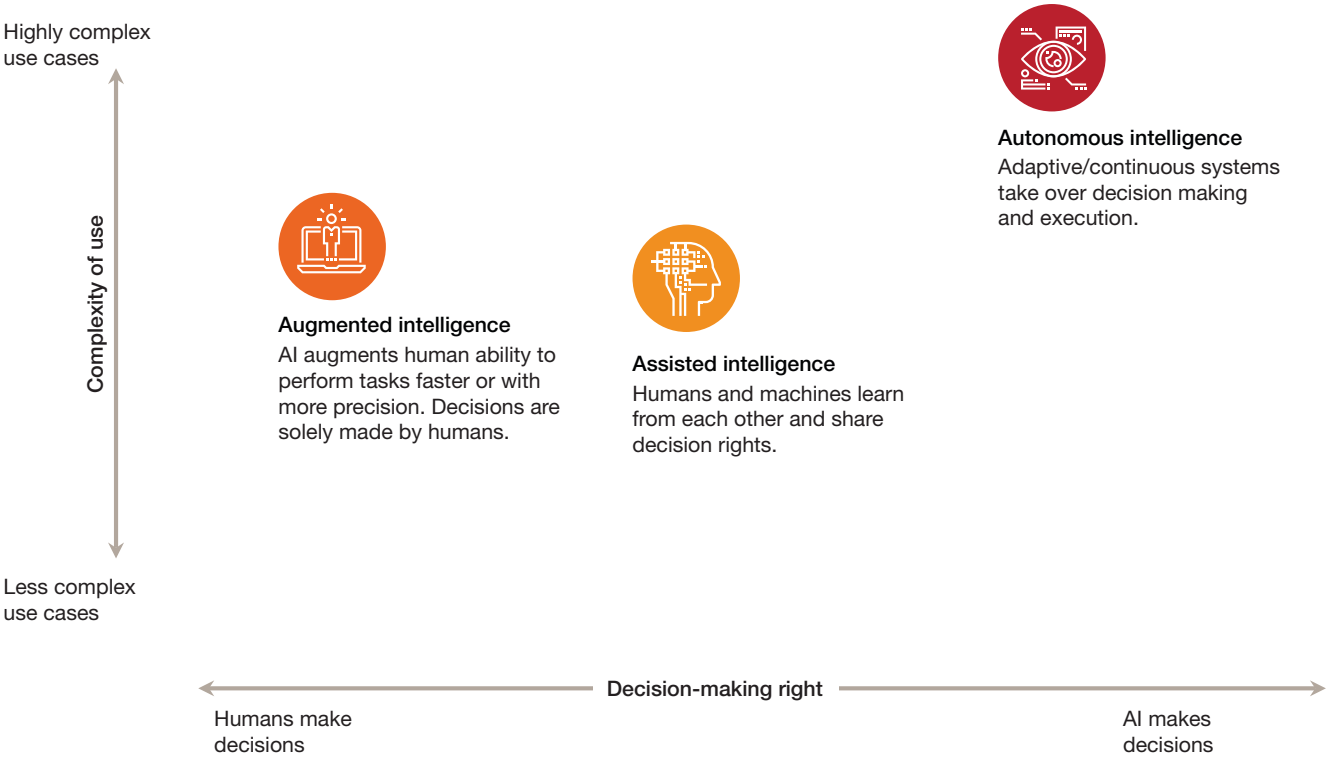
Humans and machines learn from each other and redefine the breadth and depth of what they do together. Under these circumstances, the human and the machine share the decision rights.

Augmented intelligence

Enhancing human ability to do the same tasks faster or better. Humans still make some of the key decisions, but AI executes the tasks on their behalf. The decision rights are solely with humans.

Autonomous intelligence

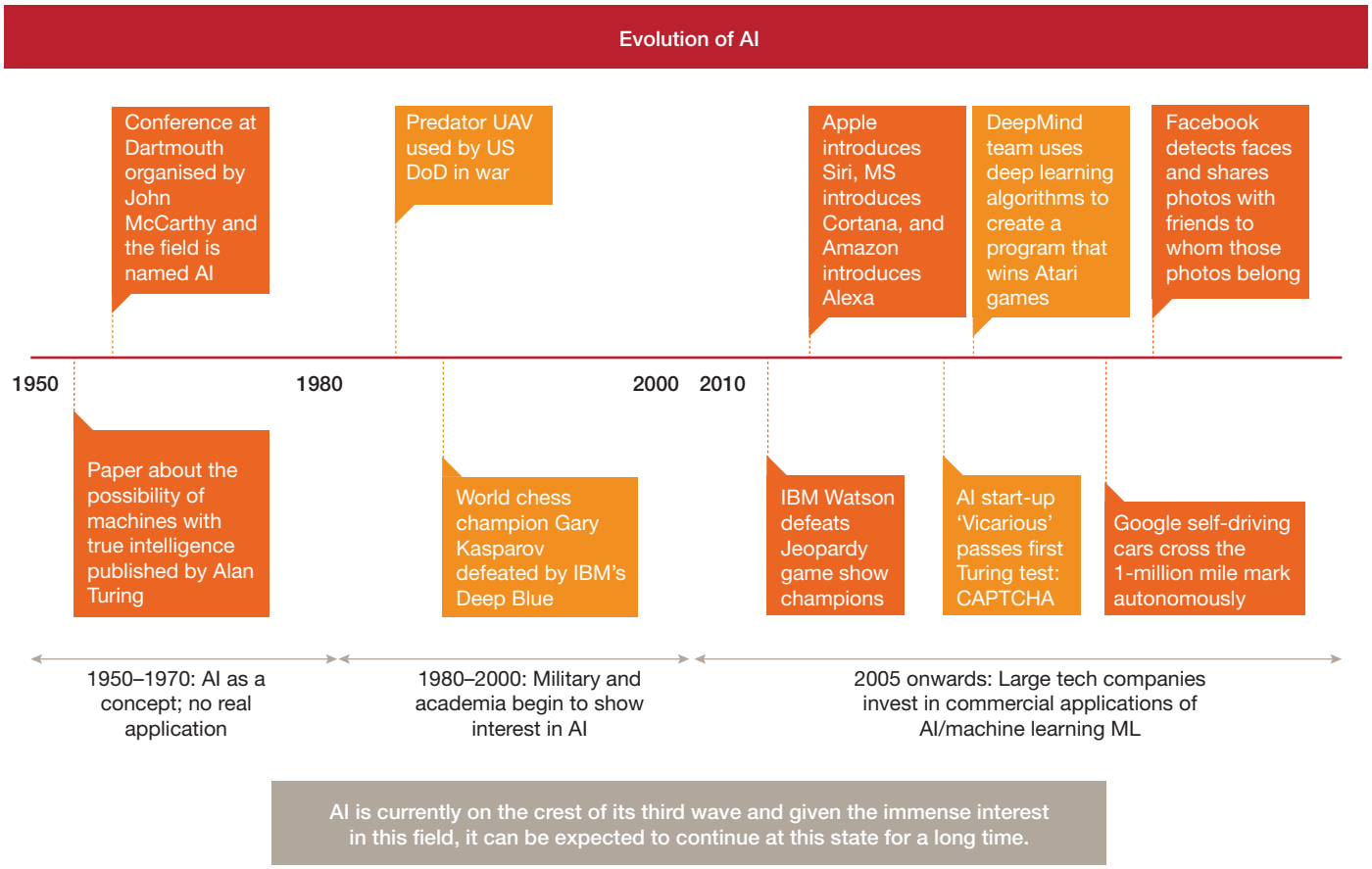
Adaptive/continuous systems that take over decision making in some cases. But they will do so only after the human decision maker starts trusting the machine or becomes a liability for fast transactions.
In this type of intelligence, the decision rights are with the machine and hence it is fundamentally different from assisted intelligence.



Source: PwC analysis

1.2 A brief history of AI

Having originated as a concept as early as the 1950s, AI research and application has come a long way during the 1980s–2000s and up to the current day. An indicative timeline, along with dominant research areas in the AI space during each period, is as follows:



Source: PwC analysis

2. AI in India

2.1 AI initiatives underway in India

Advances in AI have garnered extensive interest from the private and public sectors, with the field now being seen as a potential disruptor in the mass production of consumer goods and other labour-intensive activities from which human potential can be freed for higher endeavours.

2.1.1 Private sector

AI has subtly made inroads into the daily lives of Indian citizens in the form of app-based cab aggregators and digital assistants on smartphones. The interest can be gauged from the fact that leading IT service outsourcing companies have begun thinking, talking and (a few) launching AI platforms. But these are just small steps towards achieving the ultimate goal of AI—namely replacing human intelligence. The systems being developed, as of now, are perfecting the process of increasing the efficiency of solving a repetitive problem. This will eventually lead to solutions to ever-changing problems.

In contrast, the start-up sector is able to directly attack these problems as it does not carry the baggage of IT outsourcing firms. Indian start-ups are working across a plethora of AI problems—identifying patterns in objects, people, style and preferences to advice on retail shopping; building conversational services and using them over social media apps and for online shopping; developing better diagnostic services; bringing in cognition in robotic process automation; helping in cross-channel discovery of preferences and working in multiple languages. These are just a few of the areas that Indian start-ups are working on.

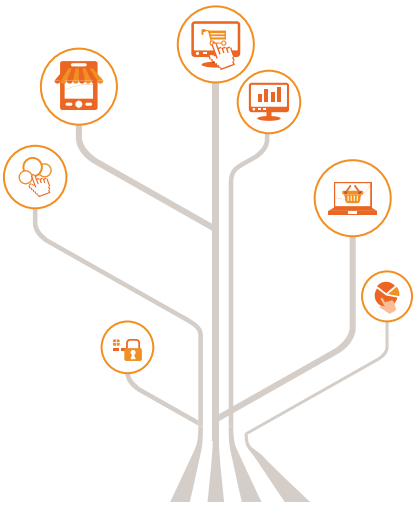
Commercial applications of AI are huge and Indian start-ups are beginning to identify them and tap into the market, which is still nascent.

2.1.2 Government and public sector

Public policy in India on the application of AI has thus far lagged when compared to AI's subtle usage by start-ups who have so seamlessly blended AI into the services provided to customers.

If we look at the applications that we use/have used at some point of time (e-commerce platforms, chat services, social media services and so on), they have all been employing AI in some form and at some level of maturity or the other. Though India is making rapid progress in terms of technology, companies and researchers are yet to utilise the full potential of AI. While the USA is currently in the process of implementing laws concerning driverless vehicles, India still lags behind. Instead of waiting for technology to reach a level where regulatory intervention becomes necessary, India could be a frontrunner by establishing a legal infrastructure in advance. Alternatively, early public sector interest in AI could trigger a spurt of activity in the AI field in India.

The main dichotomy that the regulations will have to deal with relates to who will be liable for the activities of AI systems. These systems are designed to be creative and to continue learning from the data analysed. Hence, designers may not be able to understand how the system will work in the future.



Also, the role of an AI system, as in the case of a driverless car, could be to assist the user. In such a situation, deciding liability for what the AI system has done will be difficult. Therefore, this issue needs to be discussed and delved into deeply before arriving at any conclusion.

The digital movement in India has created data which is readable by machines. At the same time, technologies have also reached a level of maturity where they can think like humans in real time and, at times, in a cost-effective way. Thus, they are suitable for use in governance.

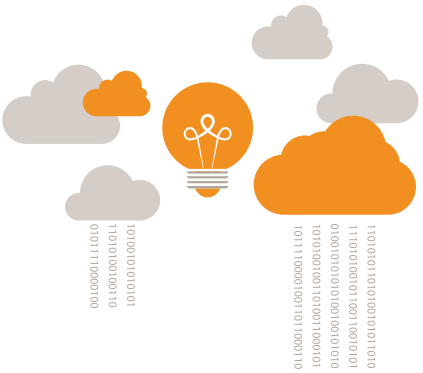
2.2 Challenges and implications

Compared to the West and frontrunners of AI adoption in Asia, such as China and Korea, the culture and infrastructure needed to develop a base for the adoption of AI in mainstream applications in India is in need of an impetus. Some prerequisites for an AI-supportive cultural environment include but are not limited to:

Homegrown infrastructure

Indian academics, researchers and entrepreneurs face a more acute challenge than corporates do in terms of the less than ideal infrastructure available for an AI revolution in India.

For example, cloud computing infrastructure, which is capable of storing large amounts of data and facilitating the huge amount of computing power essential for AI applications, is largely located on servers abroad.



An ecosystem fostering innovation

Fostering a culture of innovation and research beyond the organisation are common to global technology giants. To encourage the same level of innovation in AI research efforts in India, initiatives to hold events and build user communities in the field of AI will go a long way. Examples from around the globe include the Defense Advanced Research Projects Agency's (DARPA) Cyber Grand Challenge which attracts a large share of AI research funding in the US, the European Union's technology funding programme, FP7, and the BRAIN initiative, a 10-year, multi-billion dollar funding initiative for AI research in the US.

The European Union's Human Brain Project envisages spending 1 billion euros on AI research over the decade.

Source: 'India and the artificial intelligence revolution', S. S. Vempati, Carnegie India

2.3 AI in governance

Deep learning, a part of AI, can be employed to tackle issues of scale often prevalent in the execution of government schemes. It is essentially a process that can be used for pattern recognition, image analysis and natural language processing (NLP) by modelling high-level abstractions in data which can then be compared with various other recognised contents in a conceptual way rather than using just a rule-based method. Take for instance the Clean India Initiative directed towards the construction of toilets in rural India. Public servants are tasked with uploading images of these toilet constructions to a central server for sampling and assessment. Image processing AI can be used to flag photographs that do not resemble completely built toilets.

Image recognition capabilities can also be used to identify whether the same official appears in multiple images or if photos have been uploaded by officials from a location other than the intended site. Considering the scale of this initiative, which involves creating more functional toilets, being able to check every image rather than a small sample will actually help increase effectiveness.

Further, AI can be applied to the Prime Minister's initiatives such as the Digital India Initiative, Skill India and Make in India with varying effects. The range of application for AI techniques in such large-scale public endeavours could range from crop insurance schemes, tax fraud detection, and detecting subsidy leakage and defence and security strategy.

The Make in India and Skill India initiatives can be heavily augmented as well as disrupted by AI adoption in the short term. While the former is aimed at building the nation-wide capabilities required to make India a self-sustaining hub of innovation, design, production and export, the latter seeks to aggressively build and enhance human capital.

However, the point to consider here is that if investments are made in the two initiatives without due cognisance of how Industry 4.0 (the next industrial revolution driven by robotic automation) may evolve with respect to demand for workforce size and skill sets, there is a possibility of ending up with capital-intensive infrastructures and assets that fall short of being optimised for automated operations and a large workforce skilled in areas growing beyond the need for manual intervention only.

AI can also be consumed in traditional industries like agriculture. The Department of Agriculture Cooperation and Farmers Welfare, Ministry of Agriculture runs the Kisan Call Centers across the country to respond to issues raised by farmers instantly and in their local language. An AI system will help assist the call centre by linking various available information. For example, it could pick up soil reports from government agencies and link them to the environmental conditions prevalent over the years using data from a remote sensing satellite. It could then provide advice on the omtimal crop that can be sown in that land pocket. This information could also be used to determine the crop's susceptibility to pests. Necessary pre-emptive measures can then be taken—for instance, supplying the required pesticides to that land pocket as well as notifying farmers about the risk. With a high level of connectivity, this is a feasible and ready to deploy solution which uses AI as an augmentation to the system.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3. Global policy initiatives

3.1 Policy initiatives undertaken globally

Some of the key policy initiatives undertaken in countries around the world area are as follows:

United States

In the National AI R&D Strategic Plan, the United States government has laid stress on channelling investments to drive discovery and insight in the field of AI and ML.

More specifically, the plan calls for greater focus on broad 'general AI' in place of 'narrow AI' that traditionally aims at specific tasks: for example, moving from speech recognition to video recognition and translation. General AI will find application in a broader range of cognitive domains, including learning, language, perception, reasoning, creativity and planning.

South Korea

The government of South Korea (Ministry of Science, ICT and Future Planning) has been investing in ExoBrain from 2013. ExoBrain is a language analysis and self-learning system with the capacity to store large volumes of data for learning and subsequent analysis. The investment of around 83 million EUR will last for 10 years.

South Korea has announced $840 Million Public-Private Partnership spanning six corporations to drive AI research.

Source: 'India and the artificial intelligence revolution', S. S. Vempati, Carnegie India

China

Internet giants in China are increasingly focusing on AI research, with domestic venture capital funding being directed towards this field. Many private players are fast rising in AI research capabilities, some of whom have their own AI research labs.

A study by Japan's National Institute of Science and Technology Policy found China to be a close second to the U.S. in terms of the number of AI studies presented at top academic conferences.

Source: 'In 2017, China is doubling down on AI', Jamie Condliffe, MIT Technology ReviewS. S. Vempati, Carnegie India

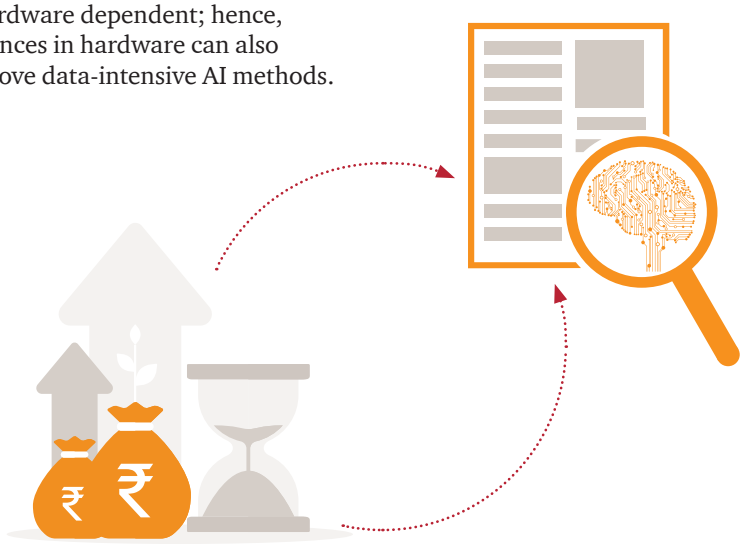
3.2 Key areas for policy planning

Securing long-term investment in AI research

While incremental research with predictable outcomes is an important ongoing activity in the AI research space, long-term investments in high-risk areas have the potential to lead to high-reward payoffs.

Investments in AI research should be directed keeping in mind multiple aspects that come together to deliver a commercial or social field of application. These include advancements in:

- **Methodologies for knowledge discovery:** Many open research questions in AI centre around the creation and use of data, its veracity and appropriateness. Further research is required to improve the data cleaning techniques by discovering inconsistencies and anomalies.
- **Research on broader and multi-purpose AI:** The long-term objective of AI is to create systems that demonstrate the adaptability of human intelligence across different domains. This will enable AI systems to transfer knowledge from one domain to another and interactively learn from humans.
- **AI system scalability:** Networks of AI systems including humans may coordinate to perform tasks not possible with a single AI system. The use of multi-AI systems creates research challenges in terms of scalability. Future research must focus on techniques for planning, control, and collaboration of multiple AI systems and humans.
- **Improved reliability of AI systems:** Robotics shows promise in complementing, augmenting, enhancing and emulating human intelligence, which calls for research efforts to make them more capable, reliable and easy to use.
- **Hardware improvement to support innovation:** AI system performance is hardware dependent; hence, advances in hardware can also improve data-intensive AI methods.



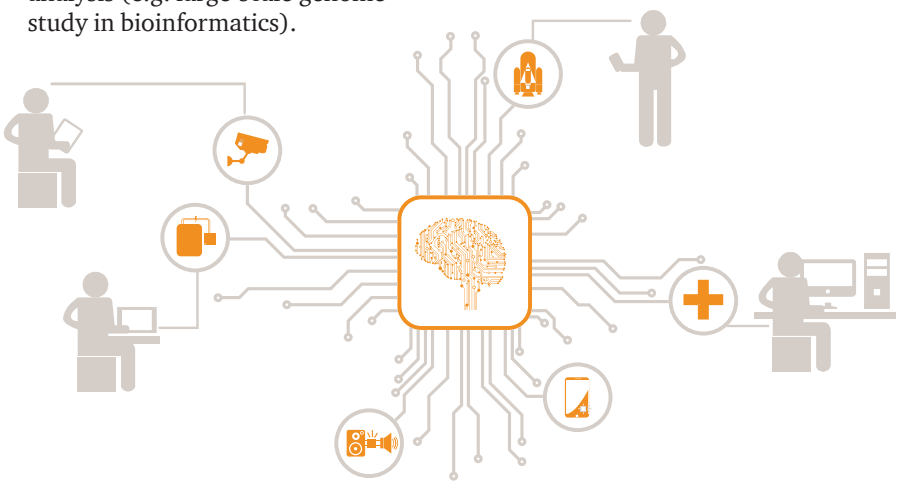
Driving human–AI collaborative applications

The goal of setting up AI systems that operate with varying degrees of autonomy is to ensure that they majorly augment and enhance human productivity rather than replace it altogether. According to PwC's Big Decisions Survey,[1] organisations are increasingly seeking to improve the speed of decision making and the level of sophistication by factoring in a larger set of parameters with greater precision and exactness in decision outcomes than human intuition can support.
For many operational and strategic decisions, the aid of AI systems in processing massive volumes of data and drawing upon sophisticated conclusions can bring organisations closer to the levels of decision-making responsiveness needed to survive in uncertain economic environments.

The extent to which AI can assist and augment human productivity depends on the role division between humans and AI and the nature of their interactions.

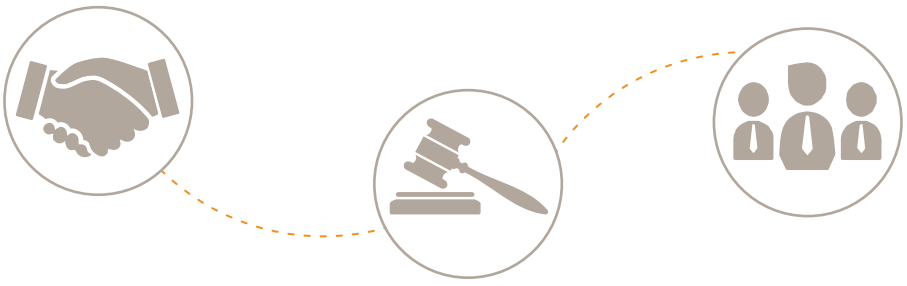
Broadly, human–AI partnerships can assume any of the following forms:

- AI performs alongside humans in a **supportive mode**, facilitating human judgment by providing resources such as predictive outputs.
- AI performs **activities that go beyond the cognitive abilities of humans**—in applications where it is physically or cognitively impossible for a human to perform precise analysis (e.g. large-scale genome study in bioinformatics).
- AI **performs in place of humans**—ideally, in environments that are potentially harmful to humans or require a superhuman reaction time (e.g. toxic environments and rapid system response in nuclear reactors).



Ethical, legal and social implications of AI solutions

To reap the societal benefits of AI systems, we would need to be able to trust them and ensure that they comply with an ethical, moral and social framework analogous to that for humans. Research efforts must be concentrated on implementing regulations in AI system design that are updated on a continual basis to respond appropriately to different application fields and actual situations.



In industries such as finance and healthcare, relevant professional ethical principles are encoded and practiced by professionals; these could form the core of AI ethics.

1. PwC. (2016). PwC's Global Data and Analytics Survey 2016. Retrieved from http://www.pwc.com/us/en/advisory-services/data-possibilities/big-decision-survey.html (last accessed on 1 March 2017)

Ensuring safety and security of AI systems

A safe and secure AI system is one that acts in a controlled and well-understood manner. The design philosophy must be such that it ensures security against external attacks, anomalies and cyberattacks.

'Adversarial machine learning' is key area the NITRD cybersecurity R&D strategic plan, that evaluates the extent to which AI systems can be contaminated by training data, modified algorithms, etc.

Source: 'The National AI R&D Strategic Plan (Oct 2016)', National Science and Technology Council, USA

Enabling environment and resources for AI training

Policy initiatives should explicitly touch upon building an incubatory environment for AI-based research and training. This includes making effective training data sets from various portals available to academicians and the public at large (e.g. Open Government Data Platform, India). Eventually, the complexity and sophistication of AI systems in delivering outputs will be a factor of the quality of training data fed into the system. Open software libraries, toolkits and development tools with low-cost code repositories and development languages such as R & Python are lowering the barriers to the use and extension of AI systems.

The IMPACT (Information Marketplace for Policy and Analysis of Cyber-risk & Trust) program (US) supports cyber-security risk research through real world data sharing capabilities in the international R&D community.

Source: 'The National AI R&D Strategic Plan (Oct 2016)', National Science and Technology Council, USANational Science and Technology Council, USA

Defining evaluation standards for tracking progress

The national policy must clearly define standards and benchmarks that can be effectively used to gauge progress in AI innovation and commercialisation in a host of application domains. By nature, the AI space is an uncertain one with no direct traceability of returns from investment in innovation and capability building. This makes it all the more important for intermediate tangible progress to be measured against set targets from time to time.

An example of an AI standard developed is P1872-2015 (Standard Ontologies for Robotics and Automation) developed by Institute of Electrical and Electronics Engineers (IEEE) for a systematic and standardized representation of knowledge for transfer between humans and AI.

Source: 'The National AI R&D Strategic Plan (Oct 2016)' - National Science and Technology Council, USAScience and Technology Council, USA

Planning for future skill demands and readiness of workforce

A strong presence in AI R&D is a prerequisite for a nation to gain a lead in an automation-driven future. For this, the national policy needs to take accurate stock of current and future demand for AI experts. Building expertise, on the other hand, will require governments to evaluate the current educational pathways and curricula and, if required, overhaul the same to provide skill upgradation initiatives for a workforce that seeks to stay relevant in a fast-evolving technology landscape.

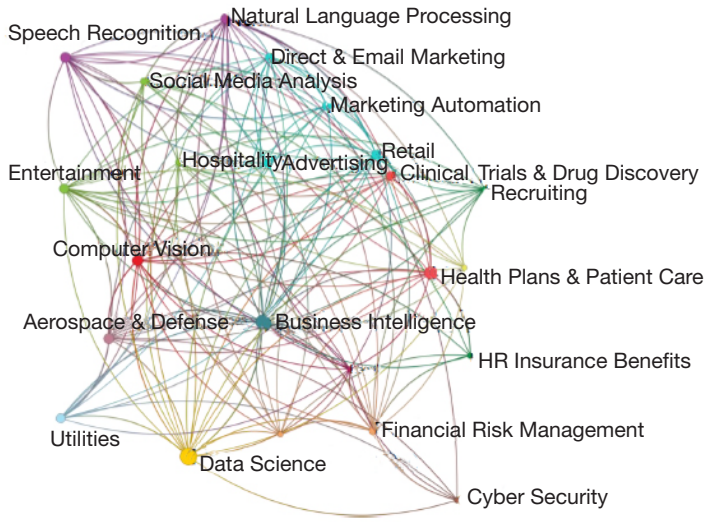
4. Impact of initiatives around AI adoption

4.1. Potential impact of AI on industries and organisations

Data science is driving the AI market, with organisations looking to leverage AI capabilities for predictive modelling. The map below shows the top focus areas organisations are trying to make inroads into by building up their AI and ML capabilities.

Area	% focus of AI
Data science	9.6%
Business intelligence	7.8%
Health plans and patient care	6.3%
Computer vision	5.6%
Speech recognition	5.3%
Aerospace and defence	5.3%
Natural language processing	5.1%
Entertainment	4.8%

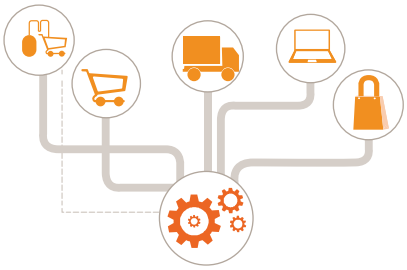
Focus areas of AI in organisations



Product manufacturing

AI augmented manufacturing operations can employ more reliable **demand forecasting**, a flexible and responsive supply chain, quicker changes in operations, and more accurate **scheduling and inventory optimisation**. Other benefits involve creation of smarter, quicker and environmentally sound processes.

The above-mentioned improvements can lead to increased productivity and quality, lower costs and a more robust health and safety framework.



Defence and security

The application of AI in the field of defence and security includes protection of infrastructure such as airports, power plants and economic sectors that are vulnerable to attacks, **detecting** anomalous behaviour in individuals, and using distributed sensors and pattern recognition to **predict infrastructure disruptions** through natural/man-made causes.

The 'security games framework' is based on computational game theory, combined with elements of human behaviour modelling. Given the limited security resources and different high-value targets, game-based decisions provide a randomised collection or patrolling schedule based on weights of targets and intelligent reactions of adversaries to security postures.

Disaster management and recovery

AI shows remarkable potential in aiding control and remedial actions in the aftermath of environmental and man-made disasters. It can assist in optimising mobile networks and smart bandwidth allocation to ensure network service continuity in the midst of catastrophic events that are usually followed by a spike in communication and jammed networks.

Unmanned drones and satellite feeds combined with image processing and recognition can be used in infrastructure damage assessments and predictions based on structural stability and traffic congestion avoidance through adaptive routing while equipping and deploying disaster management teams. Opportunities for AI intervention also reside in processing social media feeds to gauge location-specific urgency and send targeted alerts to minimise loss of life and property.

Logistics

A key area of AI intervention in logistical operations involves **adaptive scheduling** of deliveries and **routing** of vehicles. Advanced logistics and supply chains are being created using expert decision systems. Products can be transported more efficiently through vision-based driver assist and automated/robotic systems. This has made transportation less susceptible to disruptions caused by weather, traffic and unnatural events.

Financial services

Some of the major areas of application of AI in the banking and financial services sector include early detection of **financial risk** and **systemic failures**, and automation to reduce malicious intent in financial systems, such as market manipulation, fraud, anomalous trading and reduction in market volatility and **trading costs**.

Travel and transportation

AI can improve the efficiency of operations in the travel and transportation sector by bringing improved safety through **structural health monitoring** and infrastructure asset management that can pay dividends in terms of reduced cost of repairs and reconstruction and real-time route information, thereby reducing energy usage and emissions.

Agriculture

Agriculture is another sector that can greatly benefit from intelligent solutions by using smarter production, processing, storage, distribution and consumption mechanisms. AI solutions can also help provide **site-specific and timely data about crops** to enable application of appropriate inputs such as fertilisers and chemicals.

Consumer goods and services

Consumer goods and services was one of the initial areas of AI adoption in India and currently accounts for a significant share of private sector application. To enable consumers to find better products at low prices, machine learning algorithms are being deployed for better **matching of supply with consumer demand**.

Online shopping portals have extensively been using predictive capabilities to gauge consumer interest in products by building a targeted understanding of preferences through collection of browsing and click-stream data, and effectively targeting and engaging customers using a multichannel approach.

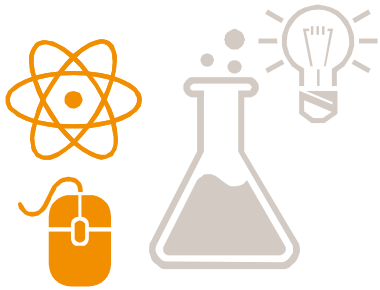
Communication and social media

In India's multilingual and multicultural society **NLP and translation** can be a potentially valuable field for the application of machine learning capabilities. Efficient usage of bandwidth and storage, improved filtering, web searches and language translation are some of the benefits of employing AI systems in the communication and social media sector.

A few Indian startups are initiating development of conversational bots, speech recognition tools, intelligent digital assistants and conversational services to be built over social media channels.

Science and technology

AI can enhance scientific research and experimentation by assisting scientists and engineers in reading publications and patents, generating hypotheses and testing them through the usage of robotic systems.



Education

Large parts of the country experience a dearth of academicians and teachers when it comes to making education effective for students across a gradient of social and cognitive abilities. AI solutions can meaningfully intervene by means of adaptive tutoring based on the receptiveness of students and accurate gauging of development of students complemented by in-person classroom learning.

Medicine and healthcare

Evidence-based treatment and medication require a level of precision that helps patients develop confidence and trust in their doctors—an area where mere manual experience and judgment may be supplemented with AI.

With the vast volume of information-processing capabilities required for fields such as bioinformatics, using AI-based algorithms and solutions is inevitable. AI application in healthcare, medicine and biotechnology includes supporting systems to identify genetic risks from large-scale genomic studies, predicting safety and efficacy of newly launched drugs, providing decision support for medical assessments and prescriptions and tailoring drug administration to the individual patient.

AI for computational pathology: The 2016 CAMELYON Grand Challenge for metastatic cancer detection found a 7.5% error rate for AI systems, a 3.5% error rate for physicians and a 0.5% error rate for physicians augmented by AI. This demonstrates the potential for collaboration between medical professionals and AI solutions.[2]

Law and order

Some of the areas where AI can improve legal processes include improved **discovery and analysis** based on law case history and formulation of legal arguments based on identification of relevant evidence.

Researchers and paralegals are increasingly being replaced by systems that can extract facts and conclusions from over a billion text documents a second. This has the potential to save lawyers around 30% of their time.

Source: PwC analysis

Audit services

Cognitive technologies are being deployed by firms to largely automate the task of going through stacks of documents to identify key terms, which has until now been a time-consuming manual process. NLP technology reads and understands key points in the documents. Machine-learning technology makes it possible to train the system on a set of sample documents so that it learns how to identify and extract information in an automated manner.

2. Networking and Information Technology Research and Development Subcommittee. (2016). The National Artificial Intelligence Research and Development Strategic Plan. National Science and Technology Council, USA

4.2. Socio-economic implications

Projected shrink in the middle-skill job market, resulting in the upskilling of the workforce

AI-driven automation raises the most commonly foreseen pitfall in society—the potential mass obsolescence of manual labour in the middle-skill order, such as factory workers and technicians. This also brings in the opportunity of upskilling the population so that other prevalent problems can be solved.

China is expected to have installed more industrial robots than any other country—30 robots per 10,000 workers. A few thousand workers have already been replaced by a robotic workforce in a single factory.

Source: 'India and the artificial intelligence revolution', S. S. Vempati, Carnegie India

Make in India, one of the Prime Minister's flagship programmes, focuses on the twin goals of strengthening India's in-house innovation and production capabilities with added creation of jobs for the middle-skilled strata of the workforce. The former goal of the programme is likely to be facilitated by large-scale AI adoption, with difficulties to be faced in meeting its latter goal.

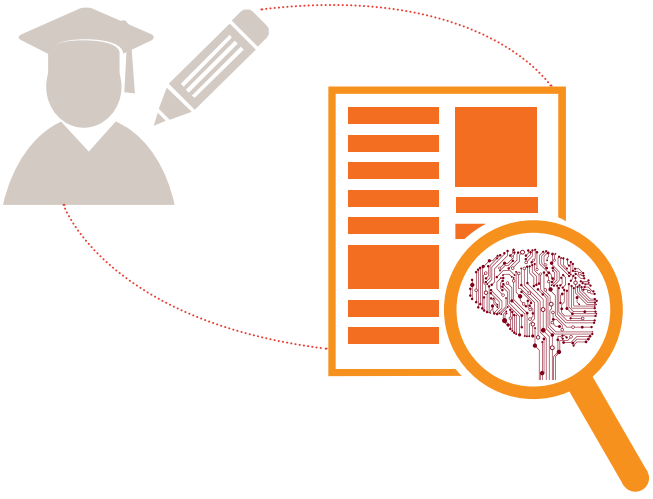
The key point here is that with robotic automation, the Make in India initiative may not end up creating nearly as many jobs as it is poised to at this point in time.

On a positive note, a scenario wherein low-skilled, repeatable labour can be assigned to robotic systems provides an incentive for part of the workforce to be trained in higher level skills such as designing, monitoring and oversight, and adjusting machine algorithms to enable AI systems to operate in a reliable and transparent manner.

It has also been argued that automation of repetitive jobs will create more time and opportunities for citizens to pursue creative endeavours such as the arts, scientific innovation and personal goals, leading to a society diverse in skills and achievements.

Balanced distribution of AI research talent

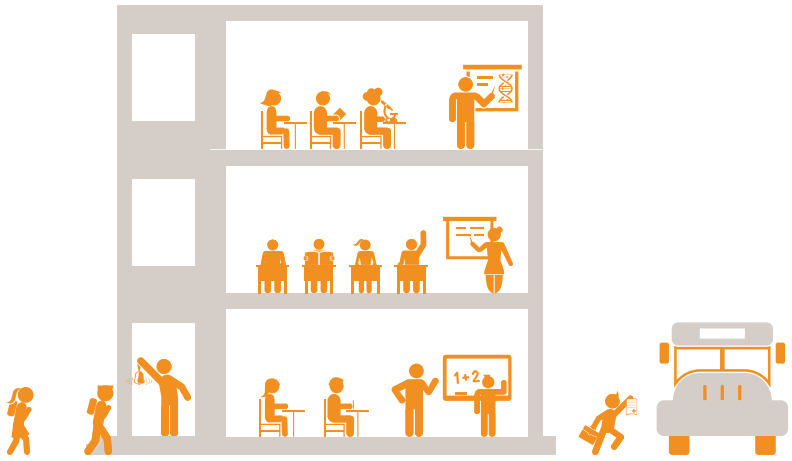
Universities struggle to retain AI talent, especially academicians studying the rapidly growing and in-demand field of ML, with talented individuals getting concentrated in a few organisations. This might lead to AI research priorities getting narrowed down to a few ventures focusing on the 'now' rather than the long-term potential across a broader range of applications.



Flexible and ongoing skill-building initiatives

The current sequential approach to skill building through a person's formative academic years may face obsolescence in a society with rapid de-skilling of jobs through robotic automation. Instead, a system that addresses the following requirements will likely better serve to sustain a whole socio-economic strata of the workforce:

- **Educate for the future:** Academic policy formulation and dissipation of knowledge should migrate from the traditional curriculum to a more specific one tailored to emerging industry demands.
- **Facilitate reskilling and lifelong learning:** Moving on from a formal education, which accounts for the initial years of an individual, policymaking must take into account the pace with which skills move in and out of demand and lay down a framework for easing transition to alternative skill sets and careers in the event of automation.



4.2.1. Tackling concerns related to loss of jobs

In light of technology advances, certain sectors are expected to experience a shrinkage of employment demand as robotic systems and ML algorithms take up several tasks. It can be expected that IT, manufacturing, agriculture, forestry, etc., will experience such a demand shift. According to Oxford University researchers Carl Frey and Michael Osborne,[3] based on 702 occupational groupings, the following types of workers have a very high probability of being replaced by automation: telemarketers, hand sewers, mathematical technicians, insurance underwriters, watch repairers, cargo agents, tax preparers, etc.

Some short- and long-term policy initiatives to cushion the impact of job losses stemming from AI-driven automation are discussed below.

Provide universal benefits outside employment structures

If a large number of people end up unemployed for extended periods of time, there needs to be a way to provide healthcare, disability and pension benefits outside employment.

Guarantee minimum income to sustain households

In the event of continuous unemployment or underemployment, government schemes to provide a minimum level of income to each citizen to guarantee basic needs are necessary to keep them out of destitution. Proposals must be structured in a way so as to maintain a balance between benefits and incentives for engagement—for example, by involving the unemployed in social and community initiatives.

Create skill re-training accounts for employees

In an era of fast technology changes, employees need an enabling environment to transition into and out of jobs. Emerging jobs will require skills different from what people learn through academics. Companies can contribute a set amount to an individual's fund which can then be transferred as the individual switches jobs. The goal of such an initiative will be to incentivise lifelong education and up-skilling.

Engage in socially beneficial volunteering activities

If people have limited employment options, they can participate in a wide range of volunteer activities undertaken by social-minded organisations. This can simultaneously ensure an engaged population and drive socially beneficial goals.

Develop a non-sequential education system

The traditional academic curriculum is not well equipped to cater to technological advancements. The sequential system of education and work is outdated in an economic environment that is heavy on automation and deskilling of jobs and where skills gain and lose value within a few years. What is required is a continuous skill improvement system that does not depend on the sequence of the skills imparted to young minds.

3. Frey, C. B. & Osborne, M. A. (2013). The future of employment: How susceptible are jobs to computerisation? Retrieved from http://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf (last accessed on 28 Febraury2017)

4.3. Economic returns from AI usage

'Global economic impacts associated with artificial intelligence'—a study funded by one of the technology giants and conducted by Nicholas Chen, Lau Christensen, Kevin Gallagher, Rosamond Mate and Greg Rafert of the Analysis Group[4] —estimated the potential economic outcome of AI using prior technological advancements such as IT investment, broadband Internet, mobile phones and, more recently, industrial robotics. The conclusion, using reasonable benchmarks, pegs the cumulative economic impact of AI to be between 1.49 trillion USD and 2.95 trillion USD through 2025.

In one case, AI intervention helped prevent significant insurance pay-out leakages. An AI company helped an insurer identify fraudulent vehicle insurance claims, which, as they predicted, would save the insurer millions of dollars a year.

Customers of AI solutions want economic outcomes through demonstrable efficiency gains and margin improvements. Accordingly, the next generation of applied artificial intelligence as a service (A-AIaaS) companies are expected to offer integrated solutions for specific use cases on a purely operational expenditure (OPEX) model. For customers, it translates to a direct positive impact on operating margins and bottom lines. For example, more than 500 companies have deals to use IBM Watson to develop commercial products and services.

4.3.1. Commercial hurdles for private firms and investors

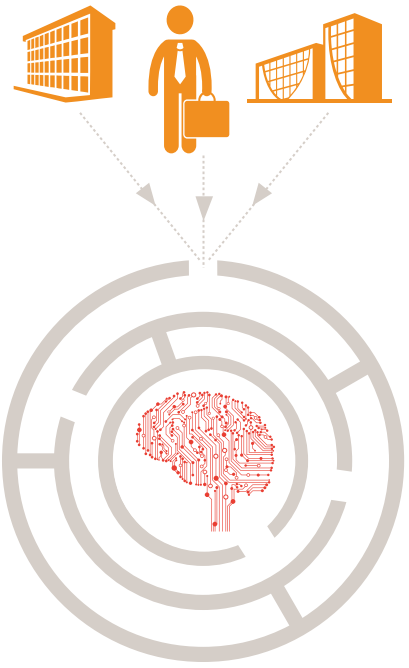
While AI adoption offers several growth opportunities, it also poses a host of commercial and financial challenges that AI operators, investors and policymakers need to consider.

Balancing research innovation with commercialisation potential: There is a significant upfront investment to be made before an AI product is considered commercially viable. Any solution coming out of this space will be subject to benchmarking against comparable manual performance and that of legacy systems in place. It is only when AI systems can significantly outperform the above that a business case for their adoption can be established.

Engineering considerations: Early into product design, engineering and production specifics such as material requirements, capacity planning, infrastructure requirements and costs should be kept in focus so as to avoid roadblocks in actually implementing and scaling up at a later date.

Longer sales cycle: AI systems are relatively novel to the potential user base who who are likely a longer time to envisage the benefits from AI immediately. This understanding needs to drive sales planning and lead to generation of conversion cycle planning.

The above challenges have important implications for potential investors in AI research and commercial start-ups. The visibility on investment break-even periods can be wildly uncertain in the AI space. A robust milestone-based progress tracking approach to track and justify the efficacy of invested capital is needed—it could range from publications, establishing user communities to creating a recurring source of revenue. A defined set of milestones needs to be met before attempting to raise the next round of capital.



4. Chen, N., Christensen, L., Gallagher, K., Mate, R., & Rafert, G. (2016). Global economic impacts associated with artificial intelligence. Boston: Analysis Group Study.

4.4. Ethical considerations

One of the major concerns in any conversation involving AI is the topic of ethical, legal and societal norms. AI research needs to base itself on a sound understanding of the various implications of any innovation and ensure alignment with rules and norms. Common concerns are the breach of privacy that might arise from an environment where hackers can exploit AI solutions to collect private and sensitive information.

A bigger threat is the misuse of ML algorithms by hackers to develop autonomous techniques that jeopardise the security and safety of vital information.

There is a need to define what 'acceptable behaviour' for an AI system translates to in its respective application domain. This should ideally drive design considerations, engineering techniques and reliability. Due diligence in ensuring that AI technologies perform in an easy to understand manner and the outcome from their applications is in line with the perception of fairness, equality and local cultural norms to ensure broad societal acceptance.

AI development will hence need involvement of experts from multi-disciplinary fields such as computer science, social and behavioural sciences, ethics, biomedical science, psychology, economics, law and policy research.

AI algorithms might, by design, be inherently subject to errors that can lead to consequences such as unfair outcomes for racial and economic classes—for example, citizen profiling based on demographics to arrive at the probability to commit crimes or default on financial obligations. AI system actions should therefore be transparent and easily understandable by humans. Deep learning algorithms that are opaque to users could create hurdles in domains such as healthcare, where diagnosis and treatment need to be backed by a solid chain of reasoning to buy into patient trust. Trustworthy AI systems are built around the following tenets:

- Transparency (operations visible to user)
- Credibility (outcomes are acceptable)
- Auditability (efficiency can be easily measured)
- Reliability (AI systems perform as intended)
- Recoverability (manual control can be assumed if required)

Owing to their vague and contextual interpretation, ethical standards pose a challenge while being encoded into AI systems. Some architectural frameworks that have been widely cited to counter the above challenge are:

- An architecture designed with operational AI distinct from a monitor agent responsible for legal and ethical supervision of any actions
- A framework to ensure that AI behaviour is safe for humans and implemented through a set of logical constraints on AI system behaviour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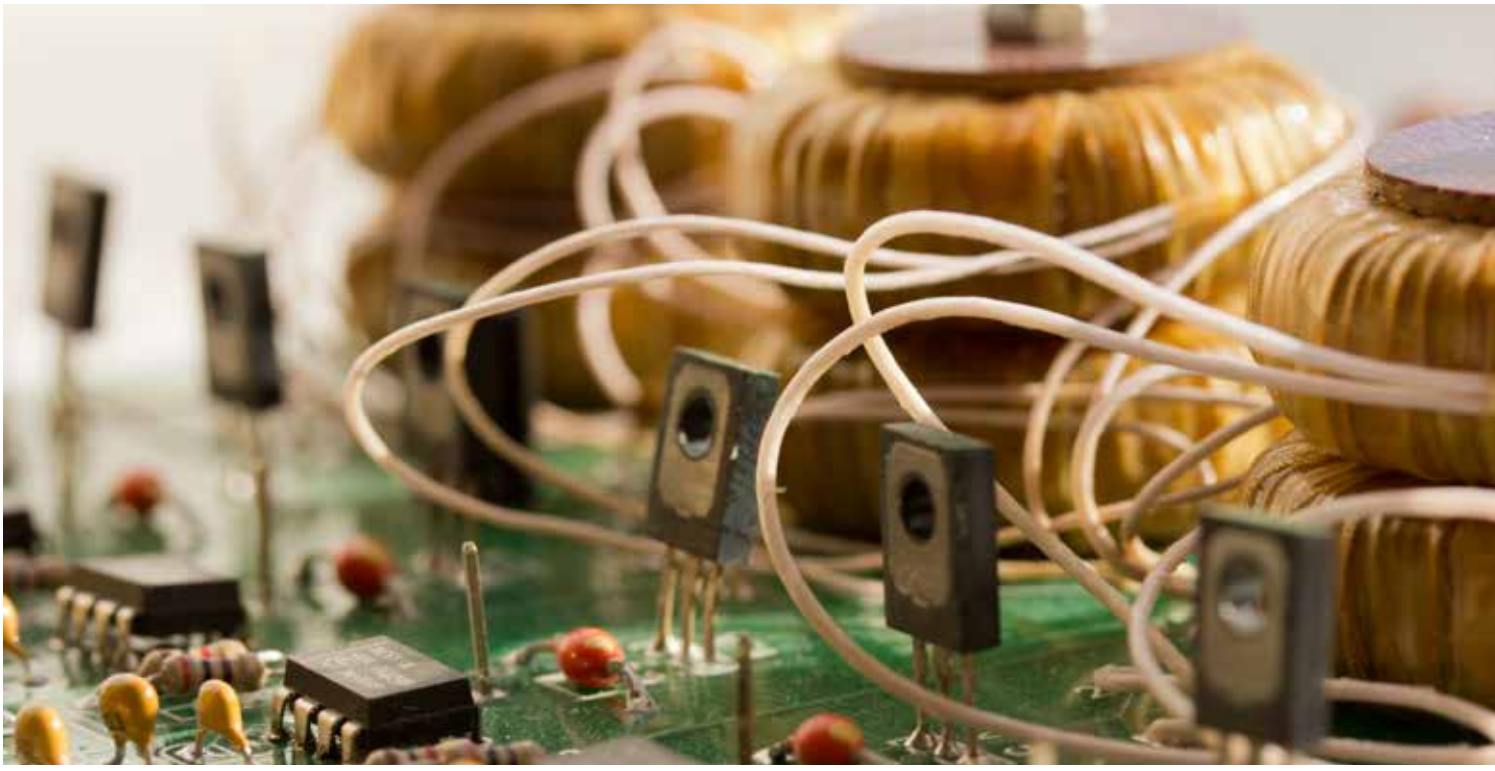
5. Looking ahead

The field of AI has awed researchers and users equally over time. Right from Alan Turing's paper in the 1950s to sci-fi movies, there has been a debate on what AI can do and how human beings will be affected by it. In many ways, this thought process and speculation are not surprising; rather, they are typical in the case of any evolving field about which complete knowledge is yet to be obtained. The only difference is that AI will constantly evolve and, hence, being able to foresee the next change becomes a big ask.

In such an environment, advances could be set in motion depending on needs and not always the other way round—that is, creating a need and then using an innovation following its development. A good amount of collaboration between academia and the public and private sectors becomes necessary. This engagement will encourage innovation in an effective and useful manner. Continuous dialogue between these three pillars (academia, public sector and private sector) will preclude the rare possibility of an innovation being at odds with human interest.

The AI continuum comes to the fore here with AI innovations that fall under augmented, assisted and autonomous intelligence helping users understand and decide which level of intelligence is helpful and required. This will make the acceptance of AI easier among the masses. At the same time, the continuum could be used to understand economic ramifications, complexity of use and decision-making implications. While academia and the private sector conduct research on various AI problems with diverse implications in mind, the public sector, with its various initiatives (Digital India, Make in India, etc.) can identify areas where parts of the AI continuum can be utilised to increase reach, effectiveness and efficiency, thus helping give direction to the innovative AI research prevalent in the country.

A collaborative innovation environment with regular dialogue between academia and the private and public sectors will help identify newer fields and operations among the population. For example, AI could be used to provide holistic and proactive advisory delivery to the population through public call centres, linking information from various government sources. At the same time, the plethora of big data generated from the interactions in the above process and other digital initiatives can be used to draw sophisticated conclusions. Collaboration between the three pillars could further help get a comprehensive view of problems and find intelligent and innovative ways to increase the efficiency and effectiveness of services delivered to society. Furthermore, these can be looked at through the lens of the AI continuum which will help provide the benefits of AI evolution to the masses according to their needs.



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D. S. Rawat
Secretary General
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HS/VB/March2017-8939