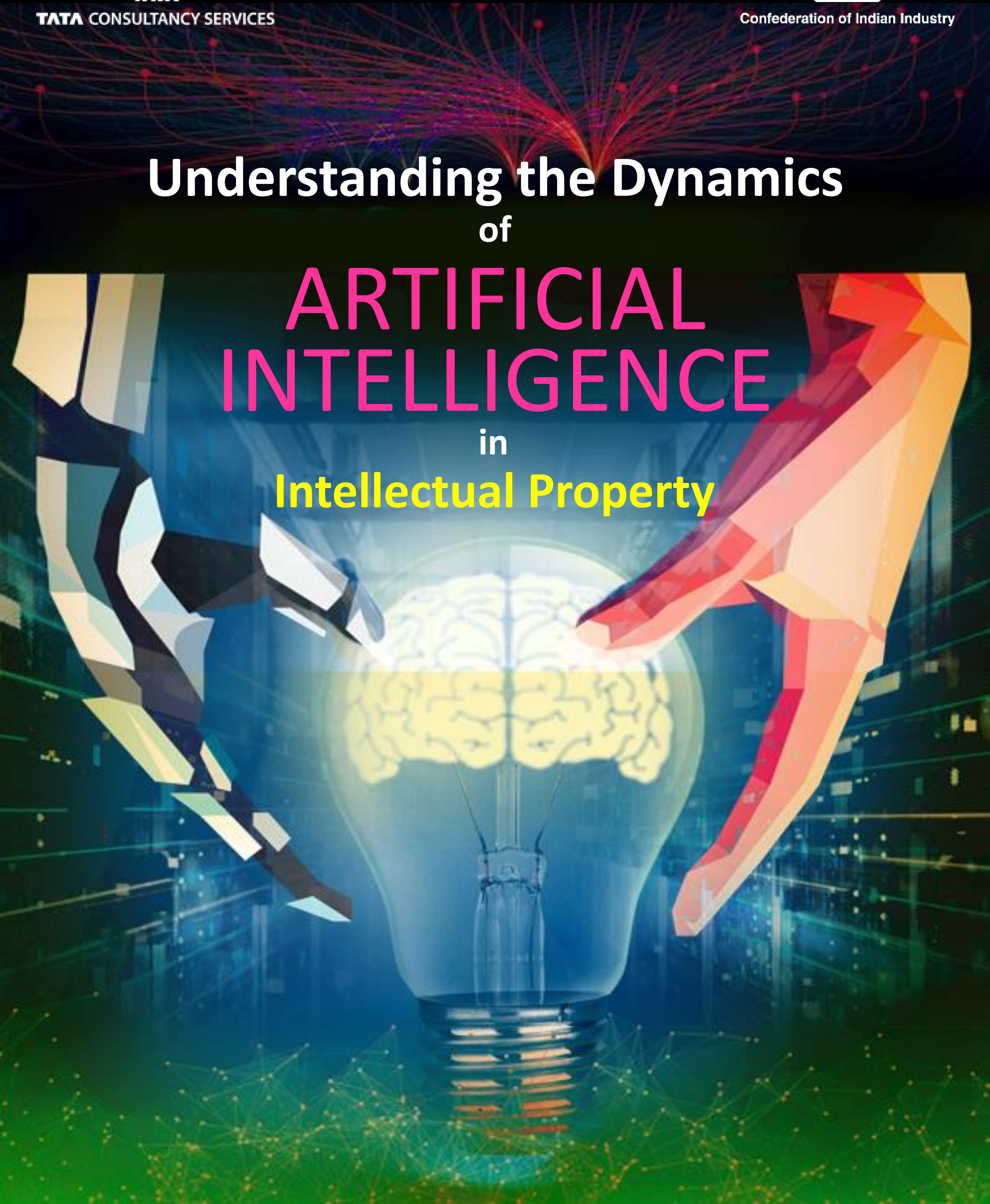
TATA CONSULTANCY SERVICES

Confederation of Indian Industry

Understanding the Dynamics of ARTIFICIAL INTELLIGENCE in Intellectual Property



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FOREWORD

Chandrajit Banerjee
Director General, CII

The report on "Understanding the Dynamics of Artificial Intelligence in Intellectual Property" prepared by the Tata Consultancy Services in close association with the Confederation of Indian Industry (CII) captures global developments, practices of various intellectual property offices of the world, technology landscape and research outlook.

This publication on IPR would provide useful information to educational & research institutions and industries doing research in this area and fill up gaps for moving forward. CII firmly believes that IPR should be at the centre stage in competing in the world of artificial intelligence in a meaningful manner. The report highlights an important recommendation that, "With evolution of new technology, it is essential to have change in the IP creation and protection ecosystem by mechanisms to develop new doctrines for new technologies, modifying the existing system to accommodate this new change and reshaping of new policies for enforcement of IPRs".

I hope that industry, policy makers, academician, researchers and start-ups will find this report useful and encourage them to examine the connected IPR needs carefully and design future plans.

PREFACE

Santosh Mohanty
Vice President and Head of IP
Tata Consultancy Services Ltd.

The Confederation of Indian Industry (CII) has organised its annual flagship International Conference on IPR to celebrate excellence in Intellectual Property through a series of panel discussions on varying aspects of IP and IP rights, and Industrial Intellectual Property Awards ceremony to recognise IP creators and promote IP culture.

The theme of the conference 'Innovation and IP Led Technology for a $5 Trillion Economy' is timely. To achieve this accelerated economic growth while addressing a wide-ranging social touchpoint, we require sustained innovation, and its adoption and scaling across social strata. This entails continuous advancement of technology knowhow, its production-grade development and supplementing processes and governance for implementation at scale.

Advancement of technology is changing every business, business model and the impact it has on society and economy. There is software in everything we do and the software itself is becoming a 'super software' with cognitive capability. We are in an interesting time and as a nation, we have an opportunity to leapfrog our journey towards a developed economy provided we stay focused and chart the path of outcome-driven innovation.

The progress made on Artificial Intelligence technology has helped in building 'super software' that makes interaction with customer 'experiential', rendering of service 'digital', manufacturing of product 'intelligently automated' and supply chain flow 'trustworthy'. Today, many AI-based applications have achieved the stated outcome for several narrowly defined areas across or within an industry segment. The field is quite open and has a huge potential to cause changes in every sphere of business and society.

India has one of the best technology talent pools in the world. If we fast track and balance our progress on innovation, IP management and entrepreneurship, we can realise the potential to become global AI powerhouse.

I am glad to see that CII and TCS have taken a proactive step in publishing the article 'Understanding the Dynamics of Artificial Intelligence in Intellectual Property'. It is a good read and I hope it will encourage researchers, academia, innovators, IP creators, solution developers, entrepreneurs, SMEs and corporates to come forward and collaborate on various aspects of AI (algorithm, data model, application area, service area, business model, talent development, ethical use and so on).

Read the article. Enjoy. Stay curious.

ACKNOWLEDGEMENTS

At the outset, we are thankful to both CII and TCS in putting up the thoughts to publish the article 'Understanding the Dynamics of Artificial Intelligence in Intellectual Property' during CII's International Conference on IPR, 2019.

We deeply appreciate the contribution from TCS team – Shailendra Langade, Narayan Subramanian, Himanshu Mehta, Jayakrishnaveni, Ganesh Rajput, Vishal Rane and Manjunath Munivenkatappa in authoring the article including editing, copyrights verification and visual design.

Himanshu Mehta and Ranjeet Goswami from TCS managed the initiative in a project mode. We appreciate their focus in ensuring timely completion and packaging.

We are thankful to R Saha, Shalini Sharma and Nabanita Mukerjee from CII for their review and guidance during content development and publication of the article.

We are grateful to K. Ananth Krishnan (EVP and CTO, TCS) and Anjan Das (Executive Director, CII) for their encouragement during the journey.

Our gratitude to Chandrajit Banerjee (Director General, CII) for the foreword and encouraging readers to examine 'connected IPR needs' carefully while designing the future plan.

Santosh Mohanty
VP and Head of IP, TCS

ABBREVIATIONS

AAAI
Association for the Advancement of Artificial Intelligence

AI
Artificial Intelligence

AIS
Assisted Intelligent Systems

CAGR
Compound Annual Growth Rate

CAS
Chinese Academy of Sciences

CRI
Computer Related Inventions

DABUS
Device for the Autonomous Bootstrapping of Unified Sentience

DL
Deep Learning

DNN
Deep Neural Networks

EPO
European Patent Office

GDPR
General Data Protection Regulation

GPU
Graphic Processing Unit

GOFAI
Good Old-fashioned AI

HR
Human Resource

IA
Intelligent Automation

IP
Intellectual Property

IPO
Indian Patent Office

IPR
Intellectual Property Rights

JPO
Japan Patent Office

ML
Machine Learning

NLP
Natural Language Processing

PETA
People for the Ethical Treatment of Animals

R&D
Research and Development

RL
Reinforcement Learning

SGCC
State Grid Corporation of China

USC
United States Code

USPTO
United States Patent and Trademark Office

VC
Venture Capital

WIPO
World Intellectual Property Organization

3D
Three Dimensional

INTRODUCTION

01

Artificial Intelligence (AI) is a multidisciplinary field of science that aims to create intelligent machines, that is, the machines that emulate and then exceed the full range of human cognition.

Contrary to the popular belief that AI revolves around science-fiction-like AI manifestation, such as super-intelligent robots, it is increasingly being embedded in less-evident practical applications, which are permeating our lives. AI-based applications today range from facial recognition to real-time language translation and from medical diagnosis to autonomous vehicles. Gradually, intellectual capabilities – understanding, reasoning, perception, communication and planning – can be taken up by software, at scale and low cost.

INTRODUCTION

1.1. AI Techniques

Although a wide range of concepts and techniques are brought together for the machines to exhibit intelligent behaviour, the algorithmic ability to learn complex patterns from data is particularly successful within the purview of AI. Listed here are some definitions of AI techniques[1].

Machine Learning (ML): Uses statistical techniques to give machines the ability to 'learn' from data without being explicitly given any instructions on how to do it.

Deep Learning (DL): Mimics the activity in the layers of neurons in the brain to learn how to recognise complex patterns in data.

Reinforcement Learning (RL): Software agents that learn goal-oriented behaviour by trial and error in an environment that provides rewards or penalties for achieving that goal.

Transfer Learning: Focuses on storing knowledge gained in one problem and applying it to a different or related problem, thereby reducing the need for additional training data and compute.

Good Old-fashioned AI (GOFAI): A name given to an early symbolic AI paradigm that fell out of favour amongst researchers.

1.2. AI Applications

Significant economic value from AI is drawn by applying DL on 'structured data'. For example, optimising the process of delivering a product based on the consumer's time preference or recommending movies to a user based on their profile and connected contextual knowledge. Yet, most remarkable breakthroughs of AI in the recent past are reported in the field of machine perception.

Computer Vision: Makes computers analyse and understand digital images or videos.

Natural Language Processing: Processes and analyses the interactions between computers and human or natural language data.

Speech Processing: Analyses speech signals, including speech recognition, natural language processing (NLP) and speech synthesis.

Predictive Analytics: Determines patterns and predicts future outcomes and trends based on the information extracted from existing data.

Robotics: Programmes robots in a way that it can interact with people and the environment in a generalized and predictable way.

Multi-agent Collaboration: Explores different models and algorithms to build autonomous systems that can work seamlessly with other systems and humans.

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A BRIEF HISTORY OF AI

A BRIEF HISTORY OF AI

We have been using AI-based technology for a long time. While some inventions were very popular and in common use, many failed to gain the market acceptance due to different challenges such as scaling, safety, accuracy and ease of maintenance. As a result, a cyclic pattern of highs and lows in AI research investment, commonly referred to as AI summers and AI winters, was seen since its inception in 1956. However, AI was getting better in an incremental way pushing forward the frontier of machine intelligence.

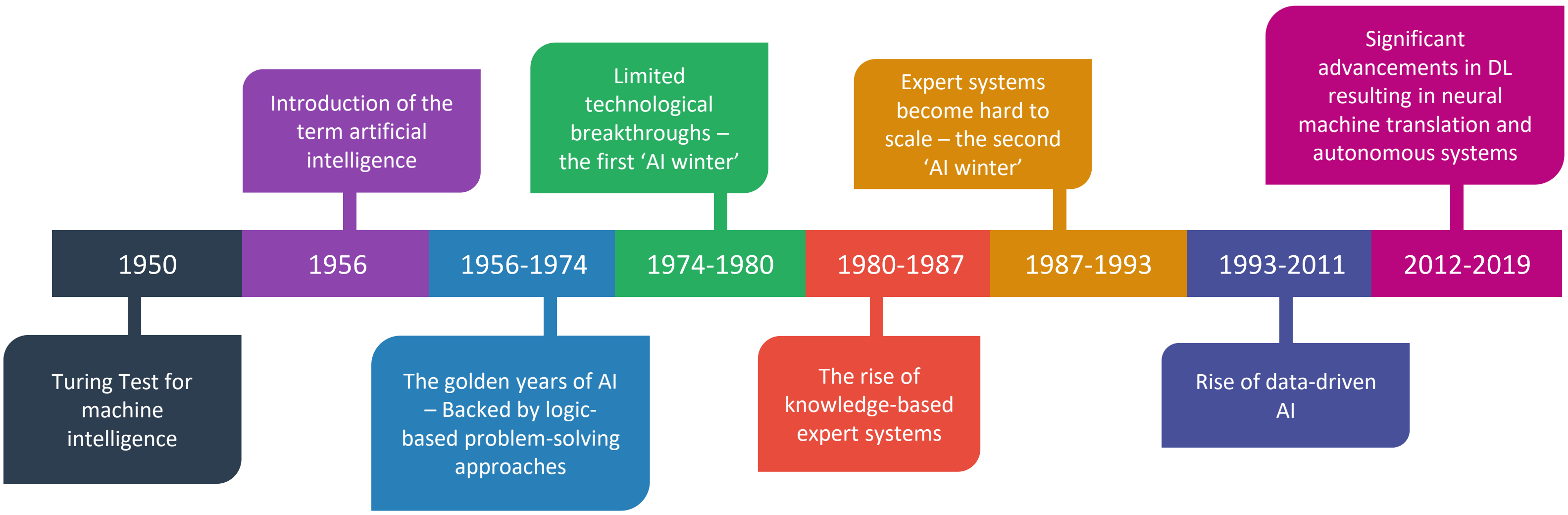

Figure 2.1: AI Timeline

2.1. The Beginning

AI first appeared in an overly optimistic project proposal by John McCarthy, Marvin Minsky, Nathaniel Rochester and Claude Shannon. In August 1955, they wrote:

'We propose that a 2-month, 10-man study of artificial intelligence be carried out during the summer of 1956 at Dartmouth College in Hanover, New Hampshire. The study is to proceed based on a conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it. An attempt will be made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves.'

At a time when computers could only take basic instructions and could not even store information, this was indeed an audacious attempt, which obviously was not able to deliver. Yet, the summer project at Dartmouth College in 1956 marked the birth of AI as a new field of study.

In the early stages, computers performed mathematical computations using algorithms and solved simple equations to find the unknown from the known. They were used to search data from a large collection of data, where the search was often based on a definite key and the data was organised in a relatively structured form.

A BRIEF HISTORY OF AI

2.2. Classical AI

Classical AI was dominated by knowledge-based reasoning. Here knowledge of different domains was represented in some standard form. Then, inference algorithms were used to iteratively invoke knowledge and arrive at a solution or decision. Expert systems of the 70s and 80s are the best examples of this kind of AI. However, they were restricted to chemistry and medicine, in which human experts designed and curated knowledge bases. In a way, expert systems became synonymous with AI as they were designed to replicate a human expert's decision-making ability.

Expert systems relied primarily on a hand-crafted knowledge base and set of rules created by humans. Their win can be attributed to their computational power, speed and memory rather than cognitive intelligence. This is also the reason for the early advancements in robotics – from self-driving cars to self-landing rockets. However, a system that functions based on only a curated knowledge base or human input cannot scale. Hence, expert systems became constrained, inflexible and expensive to maintain. Besides, many real-world challenges are too complex or subtle to be solved by simplistic logical reasoning that follows a set of rules written by human experts.

Today, knowledge-based reasoning appears under the nickname of **Classical AI** or **Good Old-fashioned AI** (GOFAI) and is sometimes utilized as a supplementary technique in DL-based AI ecosystem.

2.3. Deep Learning Revolution

Although the field of AI has been actively pursued as an academic discipline for over seven decades, only recently several forces have come together to make it practical and pervasive. Prominent forces driving the rapid advances in AI technology are:

- Internet and Internet-of-Things: Enormous amount of data digitally available
- Computing performance: Faster computers, more storage and cheaper devices and sensors
- DL: Conceptual advances in ML techniques and neural networks
- Commercial interest: Rapidly increasing investment in industrial and academic research in AI

The underlying idea is to learn from experiences and observations. The strategy is to use statistical techniques to construct a predictive model from experiential data. This model is then used to predict the responses on unseen data. Indeed, it is ML that has allowed AI to scale beyond anyone's expectations and pervade our daily lives in recent times. More specifically, 'neural networks' as a predictive model has been found to work exceptionally well in domains such as image recognition, speech recognition, language translation, and game playing. They form the basis of a class of methods called **deep learning.**

Today, applications of AI are largely based on supervised learning, wherein large amounts of labelled data are used to train models such as neural networks.

A BRIEF HISTORY OF AI

2.4. Way Ahead

The next generation of AI is expected to deal with more practical situations, where there would be no access to any data. Instead, intelligent agents must self-learn through trial and error to make decisions bearing in mind the long-term payoffs. Thus, the next-generation AI, which is still not fully realized in practice, would have more autonomy and sophistication in decision-making.

The scope of AI is not complete without robotics and autonomous systems, characterised by the physical embodiment of intelligence in the real world. One may view embodiment as an independent facet of AI. Nevertheless, it is the emphasis on embodiment that closes the loop with the real world through sensors and actuators, which helps AI to be in control.

Figure 2.2 shows the evolution of AI so far and how it can be envisioned for the near future.

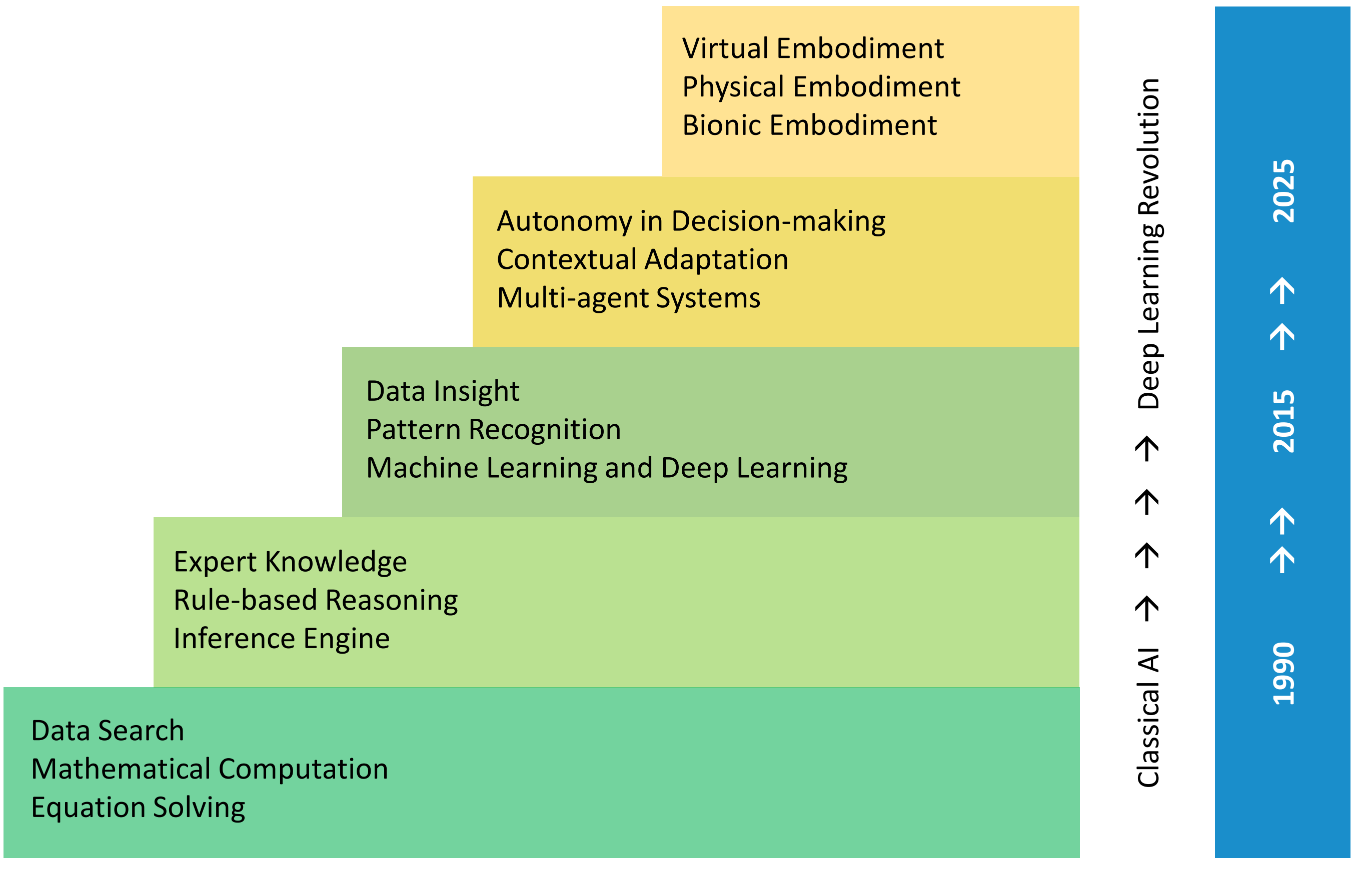

Figure 2.2: Sophistication in AI over Time

03

AI RESEARCH OUTLOOK

AI RESEARCH OUTLOOK

Computers today have become extremely capable of processing large data sets, recognising hidden patterns in the data and learning intrinsically from the data – at remarkable speed, far exceeding human capability. However, computers still lack basic intellectual capabilities such as intuition, creativity, ability to judge and ability to take an optimal decision in an unforeseen or changed situation and ability to collaborate that humans are good at. Therefore, AI today is complementary – assisting and augmenting humans. Efforts are underway to develop real intelligence akin to the human brain and the path ahead is still untrodden and open for exploration.

3.1. Liveliness of AI as a Discipline

To examine the liveliness of AI as a discipline based on scientific publications, academic enrolments and research investments, Stanford University published two consolidated measures in *The AI Index 2018 Annual Report* to reflect upon the year-on-year growth in the discipline. The first is Academia-Industry Dynamics and the second is a more abstract, single-number measure called AI Vibrancy Index.

3.1.1. AI Academia-Industry Dynamics

This derivative measure plots the growth of select academia metrics alongside the growth of select industry dynamics to explore the relationship between AI-related activity in academia and industry. The academic measures include AI paper publishing from Scopus and combined enrolment in introductory AI and ML courses at several U.S. universities whereas industry measures include Venture Capital (VC) investments in AI-related start-ups. As these metrics cannot be compared directly, each measurement has been normalized.

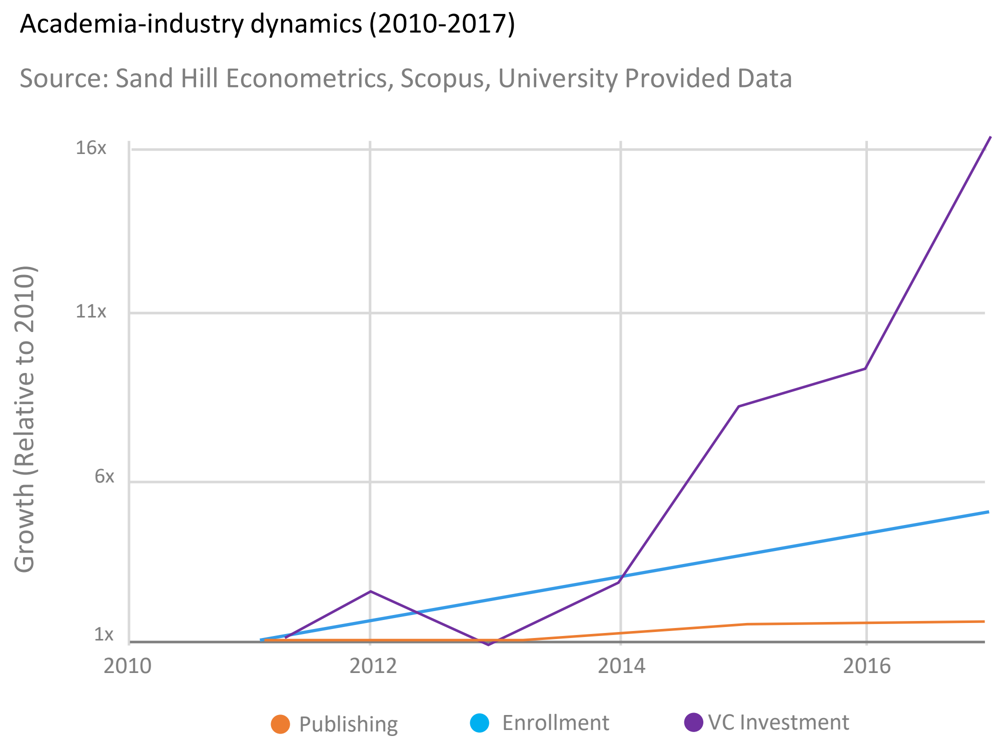

Figure 3.1: AI Academia-Industry Dynamics

AI RESEARCH OUTLOOK

3.1.2. AI Vibrancy Index

This measure aggregates the three Academia-Industry metrics (namely publishing, enrolment and VC Investment) into one measurement and all the three metrics are given equal weightage. Like Academia-Industry Dynamics, the AI Vibrancy Index is also normalized.

AI Vibrancy Index (2010-2017)

Source: Sand Hill Econometrics, Scopus, University Provided Data

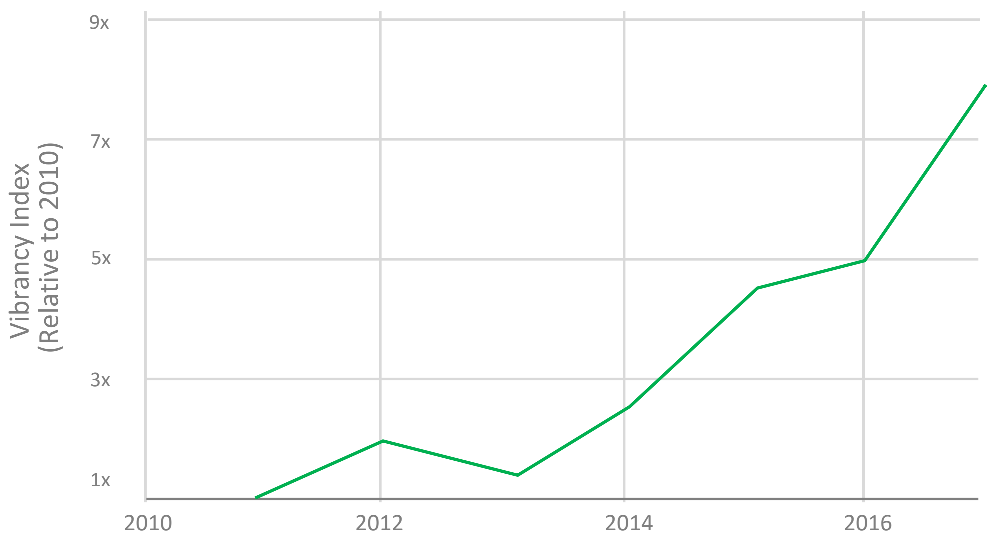

Figure 3.2: AI Vibrancy Index

Key Trends

- Increasing research papers on AI – 7 times more since 1996
- 28% of AI papers on Scopus were affiliated with European authors, followed by China (25%) and the U.S. (17%) in 2017
- 70% of submitted papers and 67% of accepted papers were from the U.S. or China at the 2018 AAAI conference
- 37% CAGR in the number of Scopus papers on Neural Networks from 2014 to 2017
- High enrolment for the 2017 introductory ML course in the U.S. – 5 times that of 2012
- 113% increase in active AI start-ups in the U.S. from 2015 to 2018
- Bigger VC funding for the U.S. AI start-ups – increased by 350% from 2013 to 2017 and 100% for all active start-ups

AI RESEARCH OUTLOOK

3.2. AI Patent Boom

As per *WIPO Technology Trends 2019: Artificial Intelligence*[3], published by World Intellectual Property Organization (WIPO), since 1960, nearly 340,000 patent families and more than 1.6 million scientific publications related to AI were published. The annual ratio of scientific papers to patent families fell from eight papers per patent in 2010 to just three papers per patent in 2015. This suggests an increased interest in the practical uses and industrial applications of AI technologies rather than pure research.

AI patent families grow by an average of 28 percent and scientific publication between 5.6 percent annually between 2012 and 2017

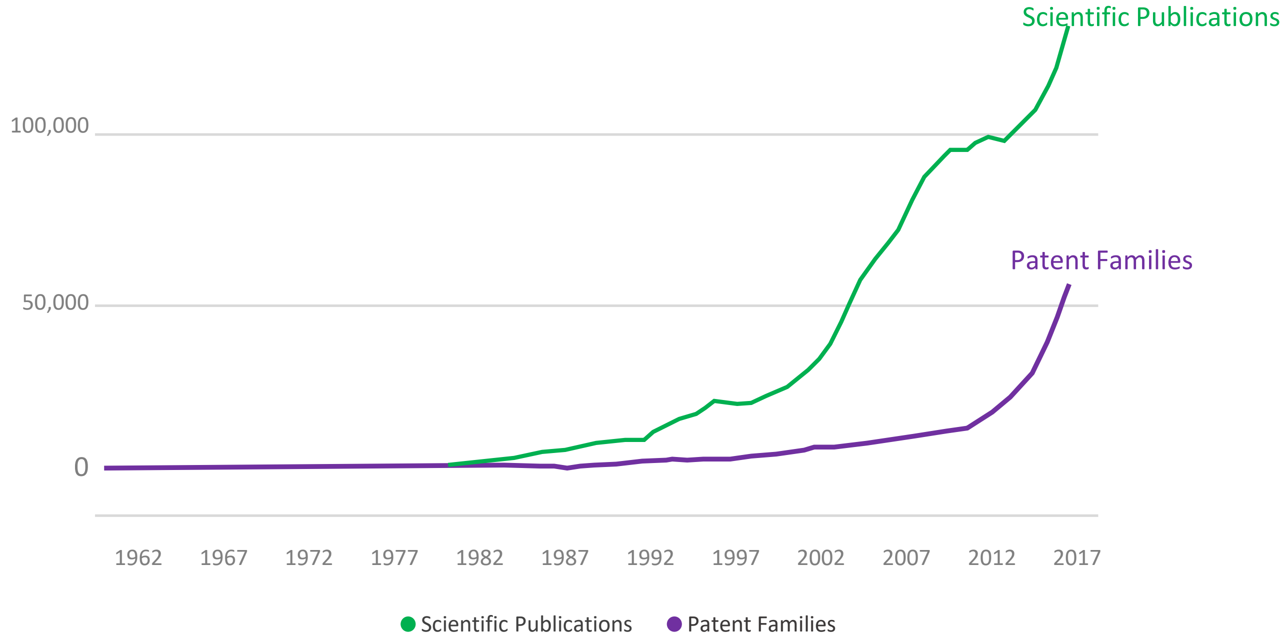

Figure 3.3: AI Patent Families and Scientific Publications (by earliest publication year)

(Source: *WIPO Technology Trends 2019: Artificial Intelligence*, World Intellectual Property Organization, 2019)

AI RESEARCH OUTLOOK

Key Trends

- 89% of the patent filed mentions the dominant AI technique ML
- ML grew by 28% from 2013 to 2016
- DL is the fastest growing technique of AI mentioned in patent filings, with a 175% increase between 2013 and 2016
- A steep increase in patent filing for multi-task learning (49%) and neural networks (46%)
- Highest number of patent families from computer vision (49%), NLP (14%) and speech processing (13%)
- Among the top 30 patent applicants, 26 of them are companies
- The top five patent applicants are IBM (8,290), Microsoft (5,930), Toshiba (5,223), Samsung (5,102) and NEC (4,406)
- The Chinese Academy of Sciences (CAS) possesses the largest patent portfolio explicitly dealing with DL (with 235 patent families)
- Baidu leads among companies owning portfolios of patents related to DL followed by Alphabet, Siemens, Xiaomi, Microsoft, Samsung, IBM and NEC
- Computer vision is the main application area for 19 of the top 20 companies, except IBM, which focuses on NLP
- The other focus with companies leading the patent filing are:
    - Speech processing: Toshiba, Panasonic, LG
    - NLP: IBM, Sharp
    - Control methods: Bosch, Siemens, Mitsubishi, LG, Toyota
    - Planning and scheduling: State Grid Corporation of China (SGCC)
    - Robotics: Sony
    - Knowledge representation and reasoning: NEC
    - Information extraction: IBM, Fujitsu, SGCC

AI RESEARCH OUTLOOK

3.3. Human-level Performance Milestones

Generally, the success of an AI invention is measured based on its performance as against human performance in carrying out a specific intellectual task, such as translating texts from one natural language to another natural language.

A list of AI achievements, where it has surpassed human-level performance, is given here. This is only a representation of some of the important successes of AI. It primarily includes game playing achievements and accurate medical diagnoses. These achievements, although impressive, do not indicate the ability of the AI systems to generalize the learnings in one specific task to any other task.

1980

Kai-Fu Lee and Sanjoy Mahajan developed Othello – Bayesian learning-based system to play the Othello

1995

Chinook, a checkers-playing programme, beat the world champion

1997

IBM's DeepBlue system defeated chess champion Gary Kasparov

2011

IBM Watson computer system won the popular quiz show Jeopardy against former winners Brad Rutter and Ken Jennings

2015

Google DeepMind used a RL system to learn how to play 49 Atari games

2016

Accuracy of automatic labelling of ImageNet improved from 72% in 2010 to more than 97% while human-level performance is about 95%

2016

Google DeepMind's AlphaGo won against the world's greatest Go player, Lee Sedol

2017

The AlphaGo Master defeated the top-ranked player, ke Jie; AlphaGo Zero defeated the original AlphaGo system

2017

AI system started classifying skin cancer as good as a certified dermatologists

2018

Microsoft's machine translation system achieved human-level accuracy in translating stories from Chinese to English

2018

OpenAI's multi-agent RL system learns to play complex real-time strategy game Dota2

2018

A DeepMind agent reached human-level performance in a popular 3D multiplayer first-person video game akin to Quake III Arena Capture the Flag

2018

Google's DL system achieved an overall accuracy of 70% while grading prostate cancer in prostatectomy specimens against the human accuracy of 61%

AI RESEARCH OUTLOOK

3.4. AI Elevating the Performance of Global Companies

Today, AI has taken the centre stage in the corporate world and the impact of AI is visible and measureable. The technology has reshaped the business models of various companies and businesses are being optimized across various business functions. Many companies are using AI to enrich their products and services for improving their global positioning and providing solutions to customers, which otherwise would have been unachievable. The passion for AI is growing and companies are looking to unleash its power to help them perform better.

Let us look at some of the key success factors[4] that determine the usage of AI across various regions in the world.

High Priority   Priority

Sr. No.	Success Factors for Using of AI	North America	Europe	Asia-Pacific	Latin America
1	Making systems secure against hacking	High Priority	High Priority	High Priority	High Priority
2	Changing our business processes to capitalize on automated decisions, actions and others	Priority	Priority	Priority	High Priority
3	Developing systems that continually learn and make better decisions	High Priority	Priority	Priority	High Priority
4	Developing systems that make good, reliable and safe decisions	High Priority	Priority	Priority	High Priority
5	Enabling employees to learn and adopt new processes and systems	Priority	Priority	High Priority	High Priority
6	Preparing managers and employees to trust what our cognitive systems are advising them to do	High Priority	Priority	Priority	High Priority
7	Determining where to use the technology in the company	Priority	Priority	Priority	High Priority
8	Obtaining executive management approval for funding	Priority	Priority	Priority	High Priority
9	Deciding whether to use the technology to help or replace people	Priority	Priority	Priority	High Priority
10	Addressing layoff fears	Priority	Priority	Priority	High Priority

Table 3.1: Key Success Factors for Usage of AI across Major Regions

Many companies view AI as a solution for better revenue growth and cost improvement. The degree to which AI affects a company depends on how AI is implemented across its different business functions. A survey conducted by TCS provides a good insight into the business function-wise impact of AI and the areas within it. Companies are categorised as 'Leaders' and 'Followers' based on the degree of impact delivered on overall revenue growth and cost management. The following table provides a view of the impact created for some of the key business functions.

AI RESEARCH OUTLOOK

Significant Impact Moderate Impact Low Impact

Business Functions	Leader	Follower
IT - Detecting and deterring security intrusions - Resolving tech user problems - Reducing production management work - Gauging internal compliance while using approved vendors - Automating run book	Significant	Significant
Customer Service - Automating call distribution - Guiding contact center reps on how to resolve customer issues - Automating responses to routine customer questions - Solving complex customer problems - Identifying training needs - Automating personnel scheduling	Moderate	Moderate
Sales - Guiding salespeople on discussions with customers: what to offer, how to negotiate etc - Qualifying sales leads and inquiries - Matching Sales Leads to the appropriate sales team - Shifting resources between online and offline sales initiatives	Moderate	Low
Finance & Accounting - Doing financial trading - Identifying potential customer credit problems	Moderate	Low
Marketing - Anticipating future customer purchases and presenting offers accordingly - Improving media buying - Monitoring social media comments and brand affinity - Tailoring promotions – online or offline - Enabling dynamic pricing	Moderate	Moderate
R&D - Enabling products to be monitored and to fix problems - Enabling products to operate without human intervention - Creating a product that can answer customer questions - Creating a product that gets smarter over time - Creating a product that protects itself against security intrusions	Low	Low
Manufacturing and Operations - Automating and adjusting staff scheduling - Scheduling and load balancing manufacturing runs - Automating plant management - Identifying and correcting assembly line problems - Automating assembly line activities	Low	Low
Corporate - Gauging customer sentiment - Identifying and advising on problems with customer payments, invoices and so on - Determining why customers buy from us - Optimizing budget allocations - Determining broad economic trends - Gauging investor sentiment	Moderate	Low
Legal - Identifying potential legal problems - Automating contract examination (or other legal documents) - Identifying legal cases	Low	Low
Distribution and Logistics - Reducing warehouse picking effort - Automating product distribution - Identifying bottlenecks	Low	Low
Procurement - Automating the request-for-quotation process - Identifying new suppliers - Identifying wasteful spending - Predicting supply shortages - Determining the best vendors to use - Identifying fraud - Identifying supplier quality problems	Low	Low
HR - Hiring better employees - Reducing hiring times - Identifying employees who need training - Improving knowledge sharing among employees - Decreasing employee turnover - Matching employees to jobs - Identifying and addressing potential areas of legal liability	Low	Low

Table 3.2: AI Impact on Key Business Functions in Companies

AI RESEARCH OUTLOOK

3.5. New Frontiers of AI

While there is significant growth and enormous success, AI has still not surpassed human intelligence in all areas. It may in the future solve complex, real-world problems but today it continues to be confounded by some fundamental challenges, which may take years to overcome.

Even today, computers cannot decipher most things a child learns before the age of six. The ability to recognise speech, understand and speak natural languages, recognise natural objects of the world, navigate in a dynamically changing environment such as a market or handle incomplete and uncertain information and yet draw useful conclusions prove tough for computers. While ML has recorded impressive results here, a key underlying weakness is a bias that creeps into the model from the training data. A classic example is a model that infers from the text that sheep are black because ‘black sheep’ occurs more commonly in the English language than ‘white sheep’. For many critical applications, even accuracies as high as 99% are insufficient for performing a task. This limits the practical adoption of several ML models. Additionally, data can often be manipulated by an adversary to mislead the model. For example, a learning-based vision system can interpret the stop sign for a speed limit sign, which would have disastrous consequences.

Though there is a good number of challenges, the sheer empirical success and the benefits demonstrated by AI are attracting genuine attention. With funding and other resources, AI can steadily overcome its limitations.

04

AI TECHNOLOGY LANDSCAPE

AI TECHNOLOGY LANDSCAPE

The development of human-like intelligence requires capabilities on certain discipline such as ability to sense and act, learning from experience, interacting with others and so on. Similarly, the pursuit of AI has naturally spawned many specialised disciplines. It is particularly instructive to view AI as a layered entity, with each additional layer enriching the underlying layer with a new degree of sophistication. This section presents a logical view of AI as a multi-layered, multi-disciplinary field of study.

4.1 Machine Learning

The ability to learn from experience (that is, experiential data) is what constitutes the basic layer of intellectual capabilities exhibited by the machines.

Statistical Learning: Many of the analytical problems such as estimation, prediction, classification and clustering of data are solved by employing supervised and unsupervised learning algorithms on large data sets. These algorithms detect hidden patterns within the available data and draw actionable insights.

Deep Learning: This is perhaps the most promising technology, where neural networks are trained on extremely large data sets leveraging GPU-powered parallel computing. The neural networks are deep, which means it has one input layer, one output layer and many hidden layers between. DL has benefited Machine Perception, which broadly comprises vision, audio, speech and NLP. The prominent use cases include object recognition, video labelling, speech recognition and machine translation.

Reinforcement Learning: In contrast to traditional ML and DL that focus on mining patterns from the large data sets, RL provides a framework for goal-oriented, experience-driven, sequential decision-making that iterates for maximising rewards (or profits) and minimising punishments (or losses) in every move in a multi-player game or negotiation.

4.2 Machine Perception

The ability to sense the environment akin to human sensory functions – vision, audio and spoken language is what constitutes the second level of intellectual capabilities exhibited by the machines.

Computer Vision: Computer vision is a form of machine perception that benefited the most by DL algorithms and used successfully in many use cases like object recognition, and video and image captioning. Today, computers have proved to be better than humans are in performing visual classification tasks of specific nature. For example, Stanford researchers have developed a DL algorithm that evaluates chest X-rays for signs of disease. In just over a month of development, their algorithm outperformed expert radiologists at diagnosing pneumonia.

Speech Recognition: DL algorithms have made speech recognition nearly accurate to be useful outside a controlled environment. The accuracy has grown beyond 95%, better than the human capability in identifying words from speech. It is built into smartphones, smartwatches and gaming consoles. It will soon become a primary channel for humans to interact with machines.

Natural Language Processing: This is an active area of machine perception with a wide variety of use cases from language modelling and text classification to machine translation to conversational systems (that is, Chatbots). The focus is shifting to the advanced variants of neural networks and the current research interest is on real-time translation and voice-based machine-human interaction.

AI TECHNOLOGY LANDSCAPE

4.3. Multi-agent Collaboration

Two fundamental ingredients to realize coordinated and collaborative interplay among multiple intelligent agents are:

Robotics and Autonomous Systems: The current research challenge is to train a robot to interact and manipulate in a dynamic environment in a predictable manner. While DL is expected to contribute largely to development of robotics, RL is expected to enable self-learning, obviating the need for large set of labelled data. Besides, reliable machine perception can be borrowed from computer vision, speech recognition and NLP to advance robotic capabilities.

Algorithmic Game Theory and Mechanism Design: This field of study models interactions between different agents (both human and automated), who may cooperate or compete. Applications include online auctions for advertising, managing patrolling schedules in airports, game playing and so on.

4.4. Knowledge Representation and Reasoning

Two concepts central to the field of AI include representation of knowledge and reasoning processes that bring knowledge to life. The knowledge representation is about encoding real world and common sense in a format that is both readable and understandable by the computer. Computers use machine-readable knowledge to reason and act. Broadly, the idea is that the machine should be capable of thinking logically.

4.5. Crowdsourcing and Human Computation

Acknowledging that the human brain is still significantly superior at performing certain operations, the field of crowdsourcing seeks to harness the ‘wisdom of the crowd’ to solve challenging computational tasks. Wikipedia is an example of a reliable, up-to-date knowledge repository that is ultimately populated with the knowledge of individual human users (rather than automated bots), but which has an automated process to organise and maintain the content.

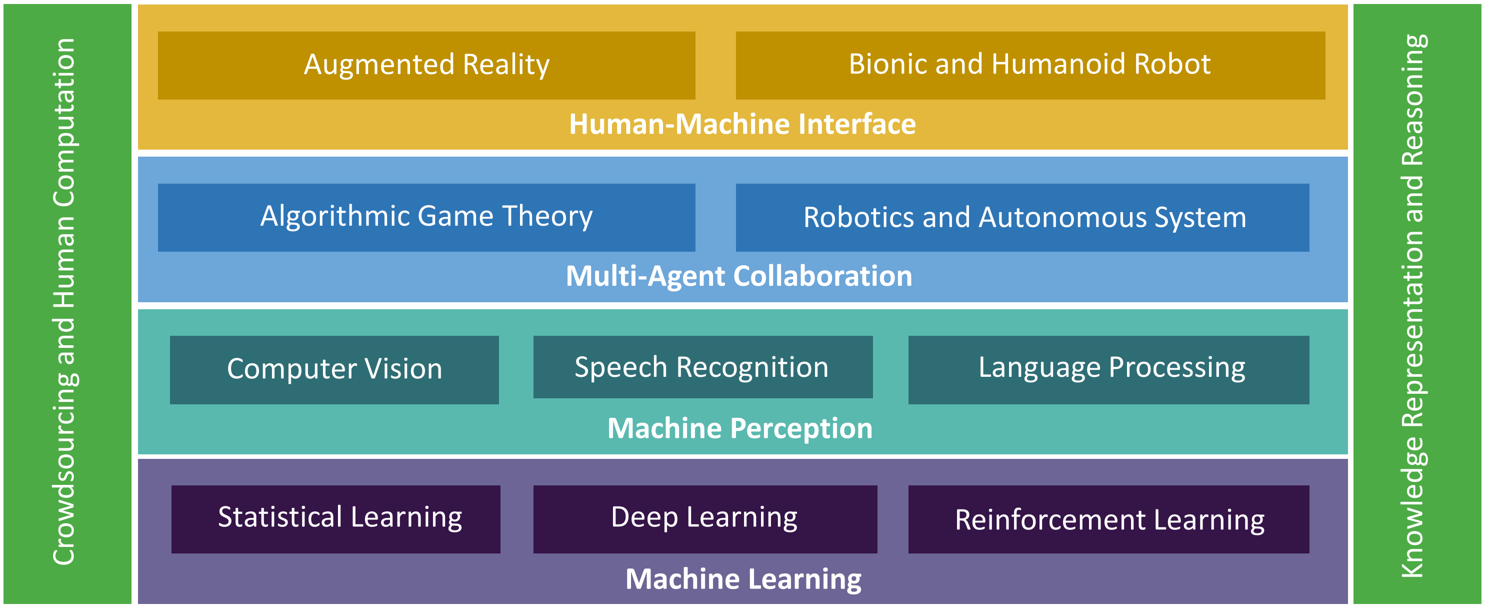

Figure 4.1: AI as a Discipline – Building Blocks

05

AI – PROSPECTS FOR IP POLICY

AI - PROSPECTS FOR IP POLICY

5.1. The Four Tenants for AI

Machines and humans have co-existed for centuries, each enhancing other's capabilities. With the advent of computers, the era of intelligent machines dawned. These machines were not only capable of automation, but also Intelligent Automation (IA). In the last three decades, technology innovations have been making rapid strides, and this is especially true in the case of computer hardware[5]. Faster hardware leads to more sophisticated software, resulting in complex interdependent systems. Such systems have taken over our lifestyle and our inherent dependence on these devices has increased many-fold. Such Assisted Intelligent Systems (AIS), which aid in our day-to-day tasks exist today. We are at the cusp of machine intelligence, which is capable of its own decision-making and is perhaps multi-faceted.

As we move away from IA to AI driven by machines, the question around implications of such a technology are growing. While there is a global race today to build such systems, a consensus around public policy that protects the larger interests of the society are missing. Strategy discussions are usually revolving around strengthening public-private partnerships, improving resource availability, data anonymization, applications of AI and so on. While these discussions are important to further the technology, the broader implications of AI's impact on society are missing. Therefore, there is a need for a strong public policy that will foster the growth of AI and at the same time safeguard societal needs. Public policy should take into consideration the guidelines or tenants for AI systems. These tenants will ensure AI technology is strictly used for human benefit.

We propose the following four tenants to drive such policies[6]:

1. An AI system may **not** cause harm (physical, emotional and financial) to a human being or through inaction allow a human being to come to such harm
2. An AI system should be **always** compliant to its purpose and may not deviate under any circumstances except when such deviations conflict with the first tenant
3. An AI system may protect its own existence, as long as such protection does not conflict with the first and second tenants
4. Child entities derived from or created by AI systems shall be subject to the first three tenants, which in turn shall be subject to tenant four

While debate around broader implications of AI is missing, the renewed focus has been around ownership. Ownership is around both data or information and technology backbone of AI-like machine learning algorithms. The following section provides an overview of the legal aspects surrounding IP rights. The evolution of the legal framework and current country-specific guidelines around IP (mostly patent) rights are discussed in the subsequent sections.

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5.2. Legal Aspects around Patent Laws, Inventorship & Data Ownership

Patents laws were created at a time when computers did not exist. Hence, they were written to exclude abstract ideas, mental acts, natural phenomenon or laws of nature. This ensured people or parties do not misuse the patent system. Today, computers and software have become an inherent part of technology. Software no longer remains constrained to the traditional rule-based system but is rather heuristic and demonstrates superior intelligence over rule-based systems. The classic demonstration of this was the matchup between the chess super engine, Stockfish, which is essentially a logic-based expert system and Deepmind's AI-based chess software, Alpha-Zero[7]. Alpha-Zero's domination pointed toward the tendency of such heuristic systems to out-perform the more traditional rule-based algorithms.

First is the aspect of eligibility for AI inventions (See section on Patentable Aspects). Though patent laws have evolved, technology evolution is growing at a much faster pace. Current patent laws treat AI software inventions essentially as logical algorithms implemented on the computer. While patent eligibility of algorithms is valid, there is little about how to deal with inventions that are heuristic in nature.

On inventorship, patent law states that someone (usually a natural person) who merely applies the logic to make something workable cannot be an inventor. So far machines were 'that someone', hence they were not a possible inventor under the law. Today, as we rely on machines for taking decisions, we have reached a crescendo where machines are intelligent to derive solutions independently or in conjunction with a natural person[8]. Naturally, the edifice of a natural person as an inventor is in question.

The other key aspect to deliberate upon is data-privacy and data-ownership issues. In a global ecosystem that involves multiple players, data is accessed and moved many times across jurisdictions. This is especially true when it comes to private data of individuals. The General Data Protection Regulation (GDPR) enacted by the European parliament is a first good step in this direction to provide guidelines on handling such data. Data ownership, that is, who owns the IP rights on inventions (which has a strong dependence on the underlying data) – the data owner or the AI scientist – is also at the forefront of the debate. Among the three, this is the most complex, and any changes will have far-reaching consequences and severe legal implications.

In summary, there are three issues – the patent eligibility aspects of AI inventions, inventorship concerns and data handling aspects. These three issues are subject to conflict and debate in the IP Community. Some feel that we should do away with old laws and introduce new laws that can herald a wave of innovation, while others feel that this can be too dangerous and would lead to unprecedented and unknown consequences. Diverse views – some driven by fear and others by greed – have derailed the process of 'patent law innovation'. Most patent offices today still confine themselves to the existing rules, providing clarifications from time-to-time, which seem to confuse rather than clarify the issue. The following sections provide a brief account of the current state of these three aspects.

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5.3. Patentable Aspects

As discussed in the earlier section, for most patent offices (with exceptions) algorithms or mathematical expressions are not patent eligible subject matter. Moreover, the mere implementation of algorithms in a computer does not meet the threshold for eligibility. The following sections provide details of the past and current legal statutes of patent eligibility in the United States, European Patent Office (EPO), China, Japan and India.

5.3.1. United States

Title 35 of U.S.C Section 101 (35 U.S.C. § 101) limits patentable subject matter to '*new and useful process, machine, manufacture or composition of matter or any new and useful improvement thereof*'. Patent claims directed to abstract ideas (for example, a mathematical algorithm), natural phenomenon or laws of nature are not eligible for patent protection.

The most recent case Alice v. CLS Bank[9] (2014) has the most twist and turns in the history of case laws involving patentable subject matter in the U.S. The court's decision decreed a two-step analytical framework for patent eligibility based on Mayo[10]. Under this framework, courts first assess whether an invention is directed to one of the judicial exceptions to patent eligibility (per 35 U.S.C. § 101). Second, if the invention does fall within an exception, courts consider whether the invention involves an '*inventive concept*,' which is an element or combination of elements '*sufficient to ensure that the patent in practice amounts to significantly more than a patent upon the ineligible concept itself*.' In other words, it validates whether there is enough in the invention to transform the abstract invention to the patent eligible subject matter.

The case McRO v. Namco demonstrates the extent of technicality to transform an abstract concept to the patentable subject matter and provides some clarity on 'significantly more'. The claimed invention relates to generating automated lip synchronisation and associated facial expression for 3D animated characters. McRO's contribution automates this process by feeding time-aligned phonetic transcripts into a computer and setting rules for how to apply various morph targets to manipulate the 3D character's facial expressions based on this input. This produces a more realistic speech pattern during animation, something that was not achievable without manual intervention. For this reason, the federal court agreed that McRO's patent overcomes the Alice test.

Further, in January 2019, the United States Patent and Trademark Office (USPTO) issued a set of revised guidelines for patent examination of abstract ideas. As per the new guidelines[11],

- The alleged abstract idea must be recited in the claims
- Claim limitation enumerated as an abstract idea must be evaluated to determine whether it falls into any of the following three categories:
    - Mathematical concepts: Relationship, formulae or equations
    - Certain methods of organising human activity: Fundamental economic principles or practices; commercial or legal interactions; managing personal behaviour or relationships or interactions between people
    - Mental processes: Concepts formed in the human mind (observation, evaluation, judgement, opinion and so on)
- Claims that recite matter falling outside the purview of these are patent-eligible
- An additional caveat allows claims if they are not directed toward an abstract idea, rather are integrated into a practical application

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The revised guidelines provide more clarity and increase the scope of patent eligibility of AI inventions (in the U.S.) when integrated into a practical application. To sum up, the patentability landscape has been changing over the past few decades. From the earlier and more direct machine or transformation test of Gottschalk to a more open-ended approach as elucidated in Bilski, Alice and McRO. The thought process of the courts has been to caution the patent offices to take a more pragmatic and precise approach while determining the patent-eligible subject matter.

5.3.2. European Patent Office

EPO has given very specific examination guidelines directed toward the patentability of the subject matter. Part G, Chapter II, Section 3 provides a list of exclusions[12]. Mathematical methods and programmes for computers are among the exclusions. The AI engine is guided by machine learning algorithms for classification, clustering, regression and dimensionality reduction, such as neural networks, genetic algorithms, support vector machines, k-means, kernel regression and discriminant analysis. The guidelines specify that '*exclusion applies if a claim is directed to a purely abstract mathematical method and the claim does not require any technical means.*' However, if a claim is directed either to a method involving the use of technical means (for example, a computer) or to a device, its subject matter has a technical character as a whole and is thus not excluded from patentability under Art. 52(2) and (3)[13]. Examples of technical applications include digital audio, image or video enhancement or analysis, de-noising and separation of sources in speech signals and speech recognition. EPO provides guidelines specifically on AI-related inventions as well. It clearly states that when an AI classification method serves a technical purpose, the steps to generate the training set and train the classifier may also contribute to the technical character of the invention, if its support achieves the technical purpose.

Thus, from a patent eligibility standpoint – an abstract invention is patentable if it is tied down to a technical purpose and its subject matter has a technical character.

5.3.3. China

The 2006 Examination Guidelines states that the followings are the rules and methods for mental activities under Art. 25.1(2) of the Patent Law and are excluded from patentability:

- Pure rules and methods for mental activities, such as a computer programme relating only to an algorithm
- Rule for mathematical computing rules
- Computer programmes per se
- Computer programmes recorded in mediums
- Rules or methods for games

As per this, if a claim is defined by rules and methods for mental activities, it shall not be eligible subject matter for a patent. However, many AI patents are being granted in China.

As in other jurisdictions, China has also revised its guidelines and case laws have provided clarity on the patent eligibility aspects. In 2015, China issued revised guidelines (Part II, Chapter 1, Section 4.2(2)), which allowed mental activities if they were tied to a technical feature. As per the guidelines, the patent examiner should investigate how the invention is incorporated in a certain technical scenario to achieve a technical effect. The patent office interpretation has been reversed by the courts as in the case AU Optronics v Patent re-examination Board. In this case, the higher court allowed the claims that were rejected by the patent office14. Their interpretation was that the patent did indeed solve a technical problem. Further clarity will come about as more such judgements come to pass.

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5.3.4. Japan

As per the Japanese Patent Office (JPO) guidelines, to be considered as statutory invention, an invention needs to be a '*creation of a technical idea utilizing the laws of nature*'. Some of the exceptions are as follows:

- Any laws other than the laws of nature (for example, economic laws)
- Arbitrary arrangements (for example, a rule for playing a game)
- Mathematical formula
- Mental activities of humans
- Those utilizing any of the above (for example, methods for doing business)

However, computer programmes (a set of instructions given to the computer) or invention of a data structure are considered as a '*creation of a technical idea utilizing the laws of nature*' and thus constitute a statutory invention. AI technologies utilising computer programmes or data structure, therefore, are in most cases patent eligible.

5.3.5. India[15]

While no AI-specific guidelines have been issued yet, patenting guidelines on Computer Related Inventions (CRI) have been deliberated in detail from the time the Indian patent amendment act of 2002 was introduced. This act introduced explicit exclusions from patentability, under section 3. These include:

- a mathematical or business method or a computer programme per se or algorithms
- a literary, dramatic, musical or artistic work or any other aesthetic creation whatsoever including cinematographic works and television productions
- a mere scheme or rule or method of performing mental act or method of playing game
- a presentation of information

The term computer programme has been defined in the Copyright Act 1957 under Section 2(ffc) as a set of instructions expressed in words, codes, schemes or any other form, including a machine-readable medium that can make the computer to perform a particular task or achieve a particular result. As per the 2002 guidelines, most computer-related inventions were deemed ineligible for patents.

These exclusions remained until 2015. The Indian Patent Office (IPO) issued guidelines in 2015, which affirmed that for a computer programme to be considered patent eligible, the subject matter should involve either '*a novel hardware, or a novel hardware with a novel computer program, or a novel computer program with a known hardware that goes beyond the normal interaction with the hardware and impacts the functionality and/or performance of the existing hardware.*' The third category presented some ambiguity. A clarification was issued to address this, which read as follows '*when running on or loaded into a computer, going beyond the 'normal' physical interactions between the software and the hardware on which it is running, and is capable of bringing further technical effect may not be considered as exclusion under these provisions.*' However, the technical effect part was not clarified. These were further revised in 2016 by introducing a 3-step test to examine such inventions, which reverted to the 2002 Act. In June 2017, these were further revised and the 3-step test was omitted. However, the most notable amendment was the deletion of the requirement that patents for software could only be claimed in conjunction with novel hardware.

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To summarize, mathematical methods that are solving purely mathematical problems/equations without specifying a practical application cannot be patented. Algorithms in any form, even if they are solving a problem are not patentable. A software can be patented, if it is an essential part of a hardware (new or existing). If it is existing hardware, the software should be capable of enhancing the technical effect. In the absence of any litigation, the interpretation of section 3(k) is still ambiguous and therefore, this remains a contentious issue.

5.4. Inventorship

5.4.1. Patents

Device for the autonomous bootstrapping of unified sentience (DABUS[16,17]) uses an artificial neural system to mimic the creative process of a human brain. It turns information it has learnt into ideas and then uses its cumulative experience to judge their merit. DABUS, a system developed by Missouri-based AI expert Stephen Thaler, is the inventor of two ideas. The first is a beverage container based on fractal geometry and the second is a light that flickers in a pattern that mimics brain activity, which is hard to ignore and therefore useful in emergencies. The invention itself should meet the basic requirements of patentability under the current patent laws in the U.S., UK and EPO. However, DABUS has been named as the inventor in these patents. This has triggered the debate on the machine as an inventor.

Human + Machine as the Inventor: When patent laws were conceived – the concept of the machine as an inventor did not exist. Therefore, patent laws worldwide bestowed the invention rights only to humans (for example, Japanese law stipulates only a natural person can be an inventor) and not to machines. This has remained true until recently. However, today we have machines contributing significantly or in some cases completely to an invention. Such cases bring back the question of inventorship, especially, when it is being co-shared with a machine. It may be meaningless to bestow these rights to machines (that is, have the machine as an inventor) as they are neither morally nor legally bound to uphold these rights. Therefore, co-sharing the invention with machines is in the likelihood to be examined.

Machine as the Inventor: Many inventions produced by AI are generally driven by Deep Neural Networks (DNN) and are heuristic in their behaviour. In such cases, we can focus on the end-result obtained from the process and not on the process itself. If the end-result meets the criteria set forth as 'sufficient to imbue a human or natural person' with an inventor status, then consequently the machine (or AI system) could also be imbued with the same status. However, as current laws[18] do not exist to support the machine as an inventor, this seems unlikely in the immediate future.

Corporate Entity or Assignee as Inventor: As per the U.S. patent law, no statute or legal instrument defines the concept of inventorship. However, the court in Fiers v. Revel explained '*The threshold question in determining inventorship is who conceived the invention. Unless a person contributes to the conception of the invention, he is not an inventor [...]. Insofar as defining an inventor is concerned, reduction to practice, per se, is irrelevant*[19].' A '*Legal Person*' however can be a non-human entity that is treated as a person for limited legal purposes. Typically, '*Legal Persons*' can sue and be sued, own property, and enter into contracts[20]. Therefore, the alternative approach is to assign rights to the controlling entity – in most cases a corporation that can assume the role of the legal person in place of the machine or AI system.

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Human as Inventor: Most countries require the 'inventor' to contribute to one or more substantive features of an invention. They believe this contribution is a result of the conception of the idea, which is not a result or outcome but the actual process that takes place in the human mind[21]. Further, conception leading toward an invention should use human faculties – something neither the machine nor a corporation possesses. Thus, concluding that neither corporations nor machines (AI systems) can be inventors. This is the current status and is likely to be maintained unless there are changes to the law.

The legal community has not been able to draw any conclusion on the inventorship of AI inventions due to these varied perspectives. Among the three – a) machine as inventor b) human developing the machine as inventor or c) corporation as an inventor – the argument leaning toward the machine as the inventor would mean changing the fabric of current legal system and will not promote the reward system, which recognizes the inventor's contribution. However, tweaking the current laws to expand the scope of the inventors to include legal entities or having machine as a co-inventor seem to be practically workable with fewer legal implications.

5.4.2. Copyright

The logic of human as an inventor applies to copyrights as well. The well-known Selfie Monkey debate involving PETA and David Slater was ruled in favour of Slater. Artworks of Picasso and other masters have been recreated by AI-based systems. In 2018, one such work was sold for 432,500 USD. With such high stakes, there are naturally claims around ownership. While claims AI system as an inventor for such artwork are presently clouded, the underlying algorithms ownership is the larger issue. In addition, the fact that AI art – and more broadly speaking, generative art – are algorithmic in nature (highly repeatable) and frequently open-source (highly shareable), and the possibility of potential authorial and copyright disputes[22] are very high.

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5.5. Rights around Data

Data concerns have been mainly about privacy and ownership. Privacy takes into consideration personal information and its use. Ownership is another contentious issue. Here the key is understanding data, whether it is representative, implied and derived.

5.5.1. Data Privacy

Many businesses claim they improve the lives of people and consumer experiences by using their personal data. But how much of this is true? With unlimited computing power and an ability to manage huge data sets, businesses are in a mad rush to compete through scrupulous or unscrupulous means. The 2018 leak on the role of Cambridge Analytica[23] and its targeted social media campaign, which may have skewed the last U.S. election result. Today data is being used or rather misused to serve business interests. This confidential data and its power to influence a decision or an election shall have far-reaching consequences than comprehensible today.

The General Data Protection Regulation (GDPR)[24] (limited to citizens of the European Union) implemented in 2018 provides a blueprint for data protection of private citizens. Among the key aspects of this regulation are:

- Extended jurisdictions around data privacy. GDPR laws will apply irrespective of where the processing of data takes place
- Strict penalties (up to 4%) or € 20 million of global turnover for violations
- Consent for data use must be sought in a clear and distinguishable form. Companies will no longer be able to use long illegible terms and conditions full of legalese
- Breach notification to be made within 72 hours from the time of the breach
- Data subjects can get confirmation from the data controller as to whether their data is being processed or used
- Data subjects can have the data controller erase their personal data on request
- Regulating privacy by design to ensure the inclusion of data protection from the onset of system design

While the U.S. laws are either sector-specific or state-specific[25], there is no single principal data protection legislation in the U.S. like the GDPR.

In India, Personal Data protection was drafted in 2018. The bill seeks to regulate the use of the personal data of individuals (data principal) by government and private entities (data fiduciaries) incorporated in India and abroad, restricts and imposes conditions on the cross-border transfer of personal data, and suggests setting up of Data Protection Authority of India to prevent any misuse of personal information. However, the bill allows the processing of data by the fiduciary for functions of the state or in compliance with any law or order of any court or in response to a medical emergency or for purposes of employment and for *reasonable purposes* as listed under Chapter 3, Section 17 of the bill[26]. The bill is yet to be tabled in the parliament[27]. A bill on non-personal data is still under preparation.

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5.5.2. Data Ownership

Machine systems in AI inventions are different from traditional inventions, as there is an inherent and critical dependence on the data. There is a heavy dependence on the training data to ensure the accuracy and consistency of the output. Moreover, the creation of accurate training datasets is dependent on the domain expertise, something that currently falls under the realm of human intelligence. This is a nebulous area where currently the rights and ownership are mainly limited to contractual clauses and not stipulated by laws. Currently, the rights around ownership of such data and its implication on patent rights is not clear, and therefore more deliberations are required.

The request for information by the United States Patent and Trademark Office (USPTO[28]) has sought comments on such issues. One such question is whether '*A new right is needed to protect these datasets, so they are more easily shareable?*' Such clarifying deliberations are steps in the right direction.

In her paper on data ownership, Scassa[29] summarizes the contexts in which data ownership issues arise. The main contexts where data ownership issues arise are as follows:

- Data commercialisation: Company and organisations tend to maintain control of the data through their activities. These are usually controlled by licensing agreements in contracts.
- Data Monopolies: Power in the hands of few may give rise to monopolies. This must be studied in the light of competition law as well, as intellectual property rights (IPR) skews rights into the hands of the owner.
- Public Dimensions: The open or public data usage may have ramifications in terms of usage of data and related rights.
- Data 'ownership' challenges: One aspect is the public-private partnership. Another aspect is when the data has changed hands several times.
- Data and Privacy: Ownership and privacy are interdependent. Private data ownership usually is in the hands of the individual and permission is sought for narrow usage of the data. However, over a period, as this information changes hands, the original premise for which permission was sought might be brought into question.

These aspects need to be taken into consideration while providing guidance on data ownership.

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Area of Interest	India	United States	European Patent Office Europe	China
Guidance around CRI, mathematical methods or algorithms	Computer-related inventions are allowed, if the software impacts a change in functionality of the underlying hardware (e.g. Lowering memory requirement)	Abstract ideas as is are not allowed, unless they are integrated into a practical application	Algorithms or mathematical methods are excluded unless the subject matter has a technical character as a whole and involves use of a technical device (e.g. computer)	Allowed if it is directed to a technical solution. Eligible subject matter is generally determined based on technical problem, technical means and technical effect
Specific guidance around patents involving AI	No specific guidelines	No specific guidelines	While the guidelines exclude purely mathematical methods, the use of these in an application may not be excluded	No specific guidelines
On the aspect of inventorship	For a person to apply for a patent, they should be a true or first inventor. However, what constitutes a true or first inventor is not defined. Developing systems that continually learn and make better decisions	No specific guidelines	Country-based rules apply. For example, German law requires an inventor to make a contribution, which is substantial and intellectual	Inventor is a person who makes creative contributions to the substantive features of the invention. The aspect of creative contribution is subject to interpretation
Laws around data protection	Personal data protection act was drafted in 2018. It regulates use of cross-border transfer and suggests setting up a Data Protection Authority. The law is yet to be enacted	No single data protection legislation. Local laws at state-level, and federal laws may apply depending on the situation	The GDPR regulation, limited to citizens of the European Union, provide a blueprint for data protection of private citizens	Personal data protection is governed by the Cybersecurity Law

Table 5.1: Summary of the Policy Guidelines around Patent Rights & Data Protection

06

AI – INTELLIGENT IP MANAGEMENT

AI - INTELLIGENT IP MANAGEMENT

With the convergence of big data, higher processing capability and cognitive intelligence, the adoption of AI-based solutions has gone into the mainstream of the IP domain. Like every business, AI has the capability to transform the current IP management into 'intelligently transformed' IP Management. Specifically, DL-based advancements in NLP and image generating and processing can directly affect IP Management activities ranging from prior art search, drafting, work allocation, examination, classification of patent portfolio management, landscape and other such analysis. Innovative solutions or designs, created by machines, which are trying to automate the creative thinking process, further bring its own set of challenges for regulating IP evaluations.

Intelligent IP management should be executed and managed at three levels:

- Data level (accessing high-quality and accurate data)
- IP system level (enabling the IP systems and tools with AI-based solutions)
- People level (empowering people to realize the benefit of AI in the IP domain)

Once the support system and ecology is set up, intelligent IP management implementation can be streamlined.

Let us understand how AI can help or has helped develop new doctrine and mechanism that shapes the future of IP ecosystem to maximize AI advantage over conventional IP management and minimize risks involved in using AI.

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6.1. Redeveloping IP Protection Mechanism

The future of managing IP lies in how efficiently enterprises are leveraging the technology to stay relevant. Today, enterprises are confronted with new challenges due to the rapidly changing environments and shorter innovation cycles in most technological areas. To survive, IP management systems must adapt to these changes for creation, usage and protection of IP.

Evolving AI technologies are drivers for developing better IP management systems. Using appropriate AI tools will allow companies to keep focus on the evolving patent landscape and determine new patents. Enterprises will heavily rely on AI-powered technologies to get the right set of prior art search reports and enable them to develop the IP of the future. The time gap between the development of the IP and the processes followed by patent offices to protect them will lead to the creation of alternative strategies for handling IP in the future. New technologies may require new meaningful mechanisms to protect and thereby pose new issues for the IP management system. Now, the need will be to optimally use the available bandwidth and display high transparency in the process. Several patent offices are working on intelligently assigning examiners based on their current workload and domain expertise. Additionally, Blockchain technology is being leveraged to ensure transparency by maintaining an audit trail of the IP lifecycle and allowing patent examiners across regional offices to collaborate and discuss the examination process.

With the evolution of new technology, it is essential to change the IP creation and protection ecosystem by:

- Developing new doctrines for new technologies
- Modifying the existing system to accommodate this new change
- Reshaping new policies for enforcement of IPRs

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6.2. Managing IP with AI

The growth of various IP portfolios by various organisations across the world poses a challenge for relevant authorities to keep pace with the increasing volume of IP rights requests, which is exceeding the processing capacity of the current IP management systems. With inventions exceedingly having cross-domain scope, an examiner requires in-depth knowledge of multiple domains to assess the claims accurately. AI-enabled systems that can either assist the personnel or automate tasks for them or advise at scale would be the utopian state for IP Management. Across organisations, with varying degrees of success, such attempts are underway. For example, the World Intellectual Property organization (WIPO) is using an AI-powered image search tool for trademarks. It is the world's first tool that is present in the WIPO Global Brand Database. It delivers accurate search results in a shorter time, thus making it highly efficient. As a result, AI delivers a cost-effective and effort-saving solution to meet the high global demand for IP rights protection.

AI-enabled systems can only be as good as the historical training data that is provided. With digitisation across organisations, such data is readily available. However, it is imperative that these systems, at this stage, continuously learn from additional training. Organisations can collaborate like the way WIPO collaborates with the member states and other institutional partners. For example, WIPO has developed a state-of-the-art neural machine translation tool, known as WIPO Translate, which is powered by AI. This tool is shared with other intergovernmental organisations and patents offices around the world to develop the tool effectively.

For the activities involved in IP management, various enablers are being created across organisations, as per their requirements. Virtual assistants for prior art search use NLP techniques to refine search strategies by providing associated terms from similar topics or concepts as well as providing search results based on semantic similarities. Conversational interfaces could guide applicants through the IP application process. Likewise, another application of AI in IP management is the automatic classification of patents and trademarks. This application helps patent examiners access and do prior art easily to determine the patentability of an invention.

IP management can greatly benefit in using AI during patent search and prosecution phase. Similarly, there could be more AI benefits that are not yet realised in IP. While the scope of IP management automation and using AI tools is colossal, it is just a matter of time when IP management will become fully automated and self-driven.

Problem Area	Remedy Using AI-enabled Solution
Increase in volume of IP right requests (e.g., Trademark)	AI powered image search tool for the trademarks
Availability of high volume of quality data for training AI powered solution	Collaboration of AI solution with trusted partners to generate quality training data
IP application translation challenges	Neural machine translation tool
Prior art search	NLP-based tool for search strategies
Patentability of invention	Automatic classification of patents for ease of prior art search

Table 6.1: High-level Mapping of AI-based Remedy to Problem Areas in IP Domain

AI - INTELLIGENT IP MANAGEMENT

6.3. Challenges in using AI for IP Management

AI-based technology solutions have been in the market for some time. However, the dominance of the technology, especially in IP management is yet to be seen because AI is good at 'specific intelligence' and not 'general intelligence'. For example, NLP algorithms work well in short sentences of 10-15 words. However, this may not work as expected in IP as it heavily depends on text analysis, where the vocabulary spans across business domains and technology and uses techno-legal language, where sentences can go up to 250 words.

We understand the benefits of AI are enormous, however, the following is a list of challenges in using AI for IP Management.

- Availability of Right Data: To improve accuracy and enhance the reliability of the AI system, a high volume of accurate data is very important. Collaboration and role for multilateralism is the key. It is crucial to have open access to data at a logical level.

- Uniform Guidelines for AI: Well understood, uniform guidelines across patent offices related to IP questions for the application of AI in IP management – for example, identifying patentability and inventorship/authorship of AI-generated IPs is still awaited.

- Dearth of AI Professionals: There is a dearth of AI knowledgeable professionals and hence, building AI for IP offices is a major challenge.

- Protection of AI Produced Inventions: It is challenging to ascertain the author or inventor of AI-generated music or image. Currently, there is no agreed mechanism to process this.

Efforts are in place to address these challenges, but it has not dampened the popularity of AI and its usage in IP and other sectors. AI is here to stay and will stay until a better technology evolves. Until then, we must work together to harness the potential of this amazing technology for the betterment of humanity.

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CII
Confederation of Indian Industry

The Confederation of Indian Industry (CII) works to create and sustain an environment conducive to the development of India, partnering industry, Government, and civil society, through advisory and consultative processes.

CII is a non-government, not-for-profit, industry-led and industry-managed organization, playing a proactive role in India's development process. Founded in 1895, India's premier business association has more than 9100 members, from the private as well as public sectors, including SMEs and MNCs, and an indirect membership of over 300,000 enterprises from 291 national and regional sectoral industry bodies.

CII charts change by working closely with Government on policy issues, interfacing with thought leaders, and enhancing efficiency, competitiveness and business opportunities for industry through a range of specialized services and strategic global linkages. It also provides a platform for consensus-building and networking on key issues.

Extending its agenda beyond business, CII assists industry to identify and execute corporate citizenship programmes. Partnerships with civil society organizations carry forward corporate initiatives for integrated and inclusive development across diverse domains including affirmative action, healthcare, education, livelihood, diversity management, skill development, empowerment of women, and water, to name a few.

India is now set to become a US$ 5 trillion economy in the next five years and Indian industry will remain the principal growth engine for achieving this target. With the theme for 2019-20 as 'Competitiveness of India Inc - India@75: Forging Ahead', CII will focus on five priority areas which would enable the country to stay on a solid growth track. These are - employment generation, rural-urban connect, energy security, environmental sustainability and governance.

With 68 offices, including 9 Centres of Excellence, in India, and 11 overseas offices in Australia, China, Egypt, France, Germany, Indonesia, Singapore, South Africa, UAE, UK, and USA, as well as institutional partnerships with 394 counterpart organizations in 133 countries, CII serves as a reference point for Indian industry and the international business community.

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TATA CONSULTANCY SERVICES

About Tata Consultancy Services Ltd. (TCS)

Tata Consultancy Services is an IT services, consulting and business solutions organisation that has been partnering with many of the world's largest businesses in their transformation journeys for the last fifty years. TCS offers a consulting-led, cognitive powered, integrated portfolio of business, technology and engineering services and solutions. This is delivered through its unique Location Independent Agile delivery model, recognised as a benchmark of excellence in software development.

A part of the Tata group, India's largest multinational business group, TCS has over 450,000 of the world's best-trained consultants in 46 countries. The company generated consolidated revenues of US $20.9 billion in the fiscal year ended March 31, 2019 and is listed on the BSE (formerly Bombay Stock Exchange) and the NSE (National Stock Exchange) in India. TCS' proactive stance on climate change and award-winning work with communities across the world have earned it a place in leading sustainability indices such as the Dow Jones Sustainability Index (DJSI), MSCI Global Sustainability Index and the FTSE4Good Emerging Index. For more information, visit us at www.tcs.com

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Confederation of Indian Industry

Understanding the Dynamics
Of ARTIFICIAL INTELLIGENCE
in Intellectual Property