ARTIFICIAL INTELLIGENCE THEORY, MODELS, AND APPLICATIONS

Edited by
P. Kaliraj and T. Devi

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Contents

Preface

The industrial revolutions Industry 4.0 and Industry 5.0 are changing the world around us. Artificial Intelligence and Machine Learning, Automation and Robotics, Big Data, Internet of Things, Augmented Reality, Virtual Reality, and Creativity are the tools of Industry 4.0. Improved collaboration is seen between smart systems and humans, which merges the critical and cognitive thinking abilities of humans with the highly accurate and fast industrial automation. The fourth and fifth industrial revolutions are affecting the roles that Indian universities and colleges prepare students for, and educational institutions are committed to help produce the workforce for this new world and the student experience to match it.

Bharathiar University has designed guidelines for Curriculum 4.0 and has prepared new syllabi for all subjects intertwining Industry 4.0 and 5.0 tools onto various disciplines such as science, social science, arts, and education. The University has identified the gap in knowledge resources, such as books, course materials, interdisciplinary curriculum, and innovative programs. To fill this gap and to prepare the future pillars of our Globe to face the Volatile, Uncertain, Complex and Ambiguous (VUCA) world, and to help the academic community, Bharathiar University has prepared guidelines for revising the syllabus, designing innovative Faculty Development Programs, establishing connectivity to the real world for students, incubating creativity and inculcating design thinking. Moreover, with the active participation of all stakeholders under the esteemed leadership of the Honorable vice-chancellor, Prof. P. Kaliraj, interdisciplinary books are being edited for Education 4.0 and 5.0.

Artificial Intelligence (AI) is a pivotal tool of Industry 4.0 in transforming the future through intelligent computational systems. AI automates repetitive learning and discovery through data. Instead of automating manual tasks, AI performs frequent, high-volume, computerized tasks reliably and without fatigue. For this type of automation, human inquiry is still essential to set up the system and ask the right questions. AI adds intelligence to existing products. Automation, conversational platforms, bots, and smart machines can be combined with large amounts of data to improve many technologies. AI is everywhere and it plays a significant role in various aspects of life. AI can be seen as a part of robotic automation, self-driving cars, healthcare and medical support, defense, online shopping, and many other technologies.

AI applications can provide personalized medicine and X-ray readings. Personal healthcare assistants can act as life coaches, reminding you to take your pills, exercise, or eat healthier. AI can analyze factory IoT data as it streams from connected equipment to forecast expected load and demand using recurrent networks, a specific type of deep learning network used with sequence data. AI provides virtual shopping capabilities that offer personalized recommendations and discuss purchase options with the consumer. Stock management and site layout technologies will also be improved with AI. In financial institutions, AI techniques can be used to identify which transactions are likely to be fraudulent, adopt fast and accurate credit scoring, and automate manually intense data management tasks.

As per the latest report of McKinsey Global Institute reports, AI is expected to create around 133 million new jobs. It shows that there is a great need for educated individuals who have expertise in this domain. And with the demand for talented engineers more than doubling in the last few years, there are limitless opportunities for professionals who want to work on the cutting edge of AI research and development. It is essential for universities and higher education institutions to offer a prescribed set of courses for a major or specialization in AI, while those with dedicated AI programs may have unique approaches to the discipline. This will create graduates who are skilled in AI and this book can aid in imparting the concepts and knowledge of AI to the graduates. This book provides a blend of the fundamentals and applications of AI with description of its fundamentals, tools, challenges, and subfields of AI. This book on AI provides relevant theory and industrial applications of AI in various domains such as healthcare, economics, education, product development, agriculture, human resource management. environment management, and marketing.

What's in the Book?

Chapter 1 entitled "*Artificial Intelligence*: *A Complete Insight*" describes artificial intelligence in detail from its basics to future applications and tools. This chapter provides a systematic understanding of artificial intelligence (AI) and will serve as a starting point for beginners to learn artificial intelligence irrespective of their domains.

Chapter 2 entitled "*Artificial Intelligence and Gender*" discusses gender disparity in the enterprises involved in the development of artificial intelligence-based software development. It also provides solutions to eradicate such gender bias in the AI world.

Chapter 3 entitled "*Artificial Intelligence in Environmental Management*" gives a brief overview of Artificial Intelligence (AI) potential in environmental management. The focus is to give a flavor of what AI could do in different areas, directly impacting the environment. The chapter presents a general framework for AI in environmental management, AI for cleaner air, AI for water preservation, AI for smart farming, AI for better e-waste management, and AI for climate control, i.e., smart energy optimization.

Chapter 4 entitled "*Artificial Intelligence in Medical Imaging*" elaborates the state-of-the-art AI, machine learning, and radiomics in medical imaging. It also describes the potentials and applications of using AI in medical imaging, including the challenges of AI in precision medicine.

Chapter 5 entitled "*Artificial Intelligence (AI)*: *Improving Customer Experience (CX)*" presents the applications of artificial intelligence in improving the customer's experience from pre-purchase to purchase and then when the customer is using the product. It mainly concentrates on the applications of AI-based technology options such as chatbots and analytics in improving customer experience.

Chapter 6 entitled "*Artificial Intelligence in Radiotherapy*" describes the applications of AI in quality assurance and safety of patients during treatment using radiation. It provides insights on the ongoing technological advancements in radiation therapy and focuses on preparing researchers and students for Industry 5.0.

Chapter 7 entitled "*Artificial Intelligence in Systems Biology: Opportunities in Agriculture, Biomedicine, and Healthcare*" introduces the uses of AI in agriculture and healthcare. It describes the applications of AI in detecting the diseases in plants, provision of proper nutritional supply to plants, drug discovery, cancer cure, medical imaging, robotics, and detection of COVID-19 symptoms.

Chapter 8 entitled "*Artificial Intelligence Applications in Genetic Disease/ Syndrome Diagnosis*" shows how AI helps in the diagnosis of various diseases, such as cancer and diabetes. Diagnosing precisely and at the earliest are achieved through AI. Existing and applied AI diagnostic measures in disease and disorders diagnosis with various parameters like EEG are elaborated in this chapter.

Chapter 9 entitled "*Artificial Intelligence in Disease Diagnosis via Smartphone Applications*" discusses how AI aids disease diagnosis in the medical field using smartphone applications. The chapter identifies and evaluates the commercially available apps for promoting early diagnosis of diseases and discusses why it is safe to install available healthcare mobile applications.

Chapter 10 entitled "*Artificial Intelligence in Agriculture*" elaborates how AI helps the agricultural domain to attain supreme quality and maximum production with reduced loss. Advanced technologies in AI relieve farmers from their hard work and toil and this chapter illustrates the various AI technologies used in the field of agriculture.

Chapter 11 entitled "*Artificial Intelligence-Based Ubiquitous Smart Learning Educational Environments*" proposes a smart learning environment framework to design and implement ubiquitous smart learning. The chapter describes how this framework can be used for successful usage, coordination, and implementation of all digital resources in the learning environment.

Chapter 12 entitled "*Artificial Intelligence in Assessment and Evaluation of Program Outcomes/Program-Specific Outcomes*" describes how AI can be used in the assessment and evaluation of program outcomes and program-specific outcomes. The various machine learning models that can be used for evaluation are discussed and the chapter reiterates the role of Artificial Intelligence in the teaching–learning process.

Chapter 13 entitled "*Artificial Intelligence-Based Assistive Technology*" briefs about the significance of AI technologies in assistive technology and analyzes the different frameworks, software, and methods developed to assist differently abled people. The chapter also provides the scope of research for designers, technologists,

and scientists to develop intelligent technologies to increase the capabilities of special needs people.

Chapter 14 entitled "*Machine Learning*" discusses as a subset of AI how machine learning works and the various machine learning algorithms in use. The various tools available for machine learning are also discussed and various application areas where it can be implemented are explained in detail.

Chapter 15 entitled "*Machine Learning in Human Resource Management*" shows how to apply machine learning techniques in human resource management. Moreover, the chapter explains the role of machine learning algorithms in human resource management, various applications of machine learning algorithms in human resource management, and presents some case studies.

Chapter 16 entitled "*Machine Learning Models in Product Development and Its Statistical Evaluation*" gives an idea about the role of machine learning models in product development through statistically monitoring the quality of the product and provides current emerging trends in product development to solve problems through machine learning algorithms.

Chapter 17 entitled "*Influence of Artificial Intelligence in Clinical and Genomic Diagnostics*" discusses the importance of artificial intelligence and machine learning and the influence of artificial intelligence in genomic data. Genomics is an interesting research area connected with the medical domain where DNA sequencing and modern drug discovery are significant research problems that depend on better machine intelligence.

Chapter 18 entitled "*Applications of Machine Learning in Economic Data Analysis and Policy Management*" covers machine learning (ML) in the context of economic policies and explores how economists can leverage technology advancements to make robust and effective policy decisions. The chapter also highlights the prevalent analytics and ML models and nuances of these models that warrant their prudent use in the economics and policy domain.

Chapter 19 entitled "*Industry 4.0: Machine Learning in Video Indexing*" shows how machine learning and data mining approaches can be used to provide better video indexing mechanisms to get better searchable results for users.

Chapter 20 entitled "*A Risk-Based Ensemble Classifier for Breast Cancer Diagnosis*" introduces a risk-based ensemble classifier that makes predictions by aggregating the predictions of multiple classifiers and calculating the expected risk for each class from the predictions. The experiments within this chapter are done on the Wisconsin breast cancer data set (WBCD) and the results produced reveal that the risk-based ensemble classifier outperforms the base classifiers.

Chapter 21 entitled "*Linear Algebra for Machine Learning*" brings out the relationship between linear algebra and machine learning. It introduces the basic concepts, such as eigenvalues, eigenvectors, and diagonalizable matrix of linear algebra; matrix decomposition theory, which is the foundation of data processing; Eigenvalue decomposition; singular value decomposition; and methods such as the linear dimensionality reduction method.

Chapter 22 entitled "*Identification of Lichen Plants and Butterflies Using Image Processing and Neural Networks in Cloud Computing*" provides the need to authenticate the lichen taxa's identity for the lichenologists. The proposed method of identifying lichen and butterflies is based on image processing and artificial intelligence using neural networks. It solves taxonomic problems and helps in understanding the evolution of taxa, including identification.

Chapter 23 entitled "*Artificial Neural Network for Decision Making*" provides a detailed explanation of artificial neural networks (ANNs). The chapter also provides a short discussion on the performance of ANNs for count modeling and concludes with a comparison study of ANNs with eminently used count models like zero-inflated Poisson (ZIP) and Hurdle models.

How to Use the Book

The method and purpose of using this book depend on the role that you play in an educational institution or in an industry or depend on the focus of your interest. We propose five types of roles: student, software developer, teacher, member of board of studies, and researcher.

If you are a student: Students can use the book to get a basic understanding of artificial intelligence and its tools and applications. Students belonging to any of the arts, science, and social science disciplines will find useful information from chapters on complete insight on AI, fundamentals, and applications. This book will serve as a starting point for beginners. Students will benefit from the chapters on applications of AI in *customer experience, agriculture, assistive technology, economic data analysis, healthcare, human resource management, disease diagnosis,* and *product development*

If you are a software developer: Software developers can use the book to get a basic understanding of artificial intelligence and its tools and applications. Readers with software development background will find useful information from chapters on fundamentals and applications. They will benefit from the chapters on *customer experience, agriculture, assistive technology, disease diagnosis,* and *product development*

If you are a teacher: Teachers will find that this book is useful as a text for several different university-level and college-level undergraduate and postgraduate courses. A graduate course on artificial intelligence can use this book as a primary textbook. It is important to equip the learners with a basic understanding on AI, a tool of Industry

4.0. chapter on *Artificial Intelligence*: *A Complete Insight* provides the fundamentals of AI. To teach the applications of AI in various sectors, say healthcare, teachers will find useful information from chapters on *disease diagnosis, medical imaging, biomedicine and healthcare, genetic disease/syndrome diagnosis, radiotherapy,* and *breast cancer diagnosis*. A course on AI for biology, too, could use the above-mentioned chapters.

If you are a member of the board of studies: Innovating the education to align with Industry 4.0 requires that the curriculum be revisited. Universities are looking for methods of incorporating Industry 4.0 tools across various disciplines of arts, science, and social science education. This book helps in incorporating AI across science, economics, and education. The book is useful while framing the syllabus for new courses that cuts across artificial intelligence and disciplines of arts or science or social science education. For example, syllabi for courses entitled artificial intelligence in science, artificial intelligence in biology, artificial intelligence in medical biotechnology, and artificial intelligence in medical physics may be framed using the chapters in this book. Industry infusion into curriculum is given much importance by involving more industry experts – R&D managers, product development managers, and technical managers as special invitees in the board of studies. Chapters given by industry experts in this book will be very helpful to infuse the application part of artificial intelligence into the curriculum.

If you are a researcher: A crucial area where innovation is required is the research work carried out by universities and institutions so that innovative, creative, and useful products and services are made available to society through translational research. This book can serve as a comprehensive reference guide for researchers in the development of experimental artificial intelligence applications. The chapters on *environmental management, improving customer experience, agriculture, economic data analysis and policy management,* and *disease diagnosis* provide researchers, scholars, and students with a list of important research questions to be addressed using AI.

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From Prof. P. Kaliraj:

First and foremost, I express my sincere gratitude to **Hon'ble Shri. Banwarilal Purohit,** governor of Tamil Nadu, India, who was instrumental in organizing the conference on Innovating Education in the era of Industry 4.0 during 14–15 Dec. 2019 in Ooty, which paved the way for further work in the Industry 4.0 knowledge world.

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I thank my wife Dr. Vanaja Kaliraj and family members for their support and being patient.

From Prof. T. Devi:

I record my sincere thanks to **Prof. P. Kaliraj**, Hon'ble vice-chancellor of Bharathiar University, who identified the gap in the knowledge world when the professor searched for a book on Industry 4.0 and triggered the process of writing and editing books in the Industry 4.0 series. His continuous motivation during the lockdown period due to COVID-19, sensitization, and encouragement are unmatchable.

I express my profound thanks to the vice-chancellor and registrar for the administrative support. Heartfelt thanks are due to the authors of the chapters for their contributions, continuous co-operation in improvizing the chapters as and when requested, and for timely communication. I thank all the expert members who served as reviewers for providing a quality and swift review.

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*****

Editors

Prof. P. Kaliraj, Hon'ble vice-chancellor, Bharathiar University, a visionary and an eminent leader leading big academic teams has had more than three decades of teaching and research experience. He has held various renowned positions, such as officiating vice-chancellor of Anna University, head of the Centre for Biotechnology of Anna University, dean of faculty at A C College of Technology, and member of the syndicate for two decades at Anna University. Professor Kaliraj had research collaborations with the National Institute of Health in Maryland, USA; Glasgow University in Scotland, UK; and University of Illinois in Rockford, USA. University Grants Commission BSR Faculty Award and the Lifetime Achievement Award from the Biotechnology Research Society of India adorned the professor. **Forty-two scholars were gifted to receive the highest academic degree under his distinguished guidance**. His remarkable **patent in the area of filariasis is a boon in healthcare** and saving the lives of mankind. He is a great motivator and very good at sensitizing the faculty, scholars, and students towards achieving academic excellence and institutional global ranking. Professor Kaliraj is a recipient of the **Life Time Achievement Award and Sir J.C. Bose Memorial Award** for his outstanding contribution in higher education – research. (email: vc@buc.edu.in, pkaliraj@gmail.com)

Prof. T. Devi, PhD (UK), Professor, Centre for Research and Evaluation, former dean of research, professor and head, Department of Computer Applications, Bharathiar University focuses on state-of-the-art technology that industries adopt in order to make students ready for the future world. She is a **Gold Medalist** (1981–1984) from University of Madras and a **Commonwealth Scholar** (1994–1998) for her **PhD from the University of Warwick, UK**. She has three decades of teaching and research experience from Bharathiar University, Indian Institute of Foreign Trade, New Delhi, and University of Warwick, UK. Professor Devi is good in team building and setting goals and achieving them. Her research interests include integrated data modeling and framework, meta-modeling, computer-assisted concurrent engineering, and speech processing. Professor Devi has visited the United Kingdom, Tanzania, and Singapore for academic collaborations. She has received various awards including **Commonwealth Scholarship and Best Alumni Award from PSGR Krishnammal College for Women (PSGRKCW), Proficiency award from PSG College of Technology and awards from Bharathiar University for serving for BU-NIRF, Curriculum 4.0, and Roadmap 2030 and guided 23 Ph.D. scholars**. Prof. T. Devi may be contacted at (email: tdevi@buc.edu.in, tdevi5@gmail.com)

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1 Artificial Intelligence: A Complete Insight

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CONTENTS

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1.1 INTRODUCTION

Evolutionary changes are common in the universe, starting from the first species reported on the earth millions of years before to the species referred to as human. These evolutionary changes include physical, structural, morphological, behavioral, and mental variations. The theory of evolution also indicates a volumetric change in the brain of the species, making the species hold identical behavior from other species. The brain is an interconnected structure of millions of neurons where communication between these neurons will decide human's internal and external behavior. The sense is another significant factor that discriminates one species from the other, even every human from another human. The five senses of human beings are touch, vision, taste, hear, and smell, and the so-called sixth sense is proprioception, which means realizing self-movement and position of the body. All these senses have a strong association with the human brain.

Darwin's theory of evolution states that *"Way of successfully completing the work or the work done smartly instead of simply completing the work will play a vital role in discriminating a person from others in terms of his/her own thinking and intelligence."* Such intelligent thinking and behavior in humans are still unpredictable, whereas birds and animals exhibit their smartness through the *survival of the fittest* theory. For example, ants have their style of constructing the shortest path from their food source to nest. Human beings considered to have superior skills than ants follow the ant path construction method for deciding an efficient path to solve critical path-based problems. Similarly, humans can also widely adopt swarm intelligence to identify and optimize the solutions for numerous issues.

Figure 1.1 shows the natural, intelligent behavior of various species. However, these species are different and unique in their nature; a rare kind of intelligence can be observed in each species behavior. Many other species such as wasp, bat, cuckoo, elephant, whale, grey wolve, moth, and chicken exhibit extraordinarily intelligent characteristics. Technological developments are playing a major role in the industrial revolution, where most of the machinery has been enhanced with the support state-of-the-art technological innovations and improvements. These innovative outcomes have a stronger influence in various domains, including civil, electrical, electronics, mechanical, medical, environmental, astronomy, and other sectors. Human intelligence is more important to complete any work efficiently as well as effectively. This intelligence and intellectual thinking of human-made massive evolutionary growth by producing various devices and machinery. This ability greatly supports industries and manufacturing units for producing materials in higher volume within the stipulated time. The simplest difference between hard work and smart work is shown in Figure 1.2. Figure 1.2a

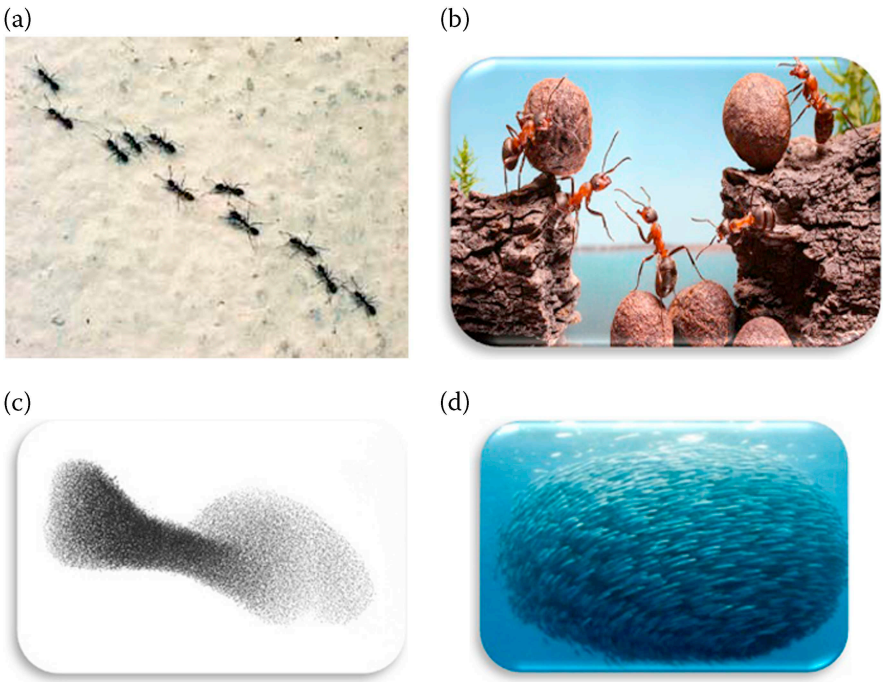

FIGURE 1.1 (a) Ant behavior, (b) smart ant behavior, (c) swarm of bees, and (d) swarm of fish.

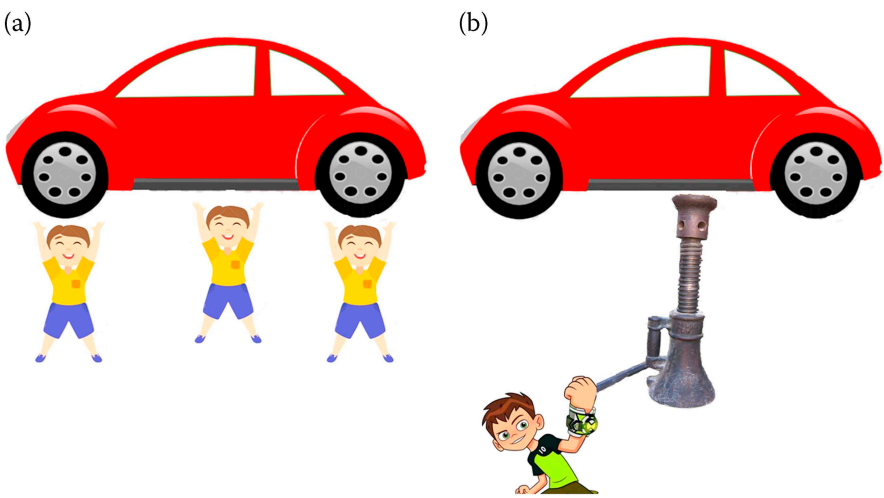

FIGURE 1.2 (a) Hard work and (b) smart work.

shows pulling up a car by a group of people whereas, in Figure 1.2b, the same work is done smartly with minimum human resources using the machine.

The latest buzzword in the industry is the *"projection and migration of industry with the support of man, machine, and automation which is referred to as **INDUSTRY 4.0.**"* Forthcoming sections will detail artificial intelligence, which is an essential factor in Industry 4.0, its history, components, AI environment, and applicability in different domains.

1.2 ARTIFICIAL INTELLIGENCE: WHAT AND WHY?

"*Intelligence*" is a fascinating term that is the best fit for debate since it involves the human brain, mind, involvement, logical thinking, understanding, and applicability. The level of intelligence varies from person to person in terms of how they perceive and perform actions. In general, intelligence can be well defined as an individual's capability to do things effectively by using their own knowledge, interpretation, and insight. The term artificial intelligence (AI) was coined by John McCarthy, a Stanford University emeritus professor of computer science, and he defines it as "the science and engineering of making intelligent machines," particularly intelligent software programs. The field of AI is mostly associated with the mission of using computers to study the intelligence and associated decision-making skills of a human (Figure 1.3).

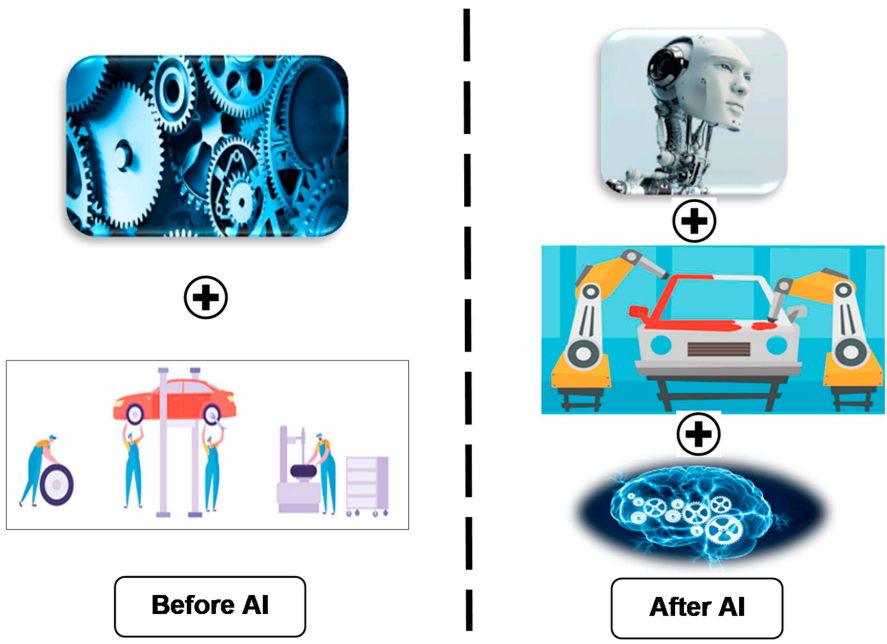

FIGURE 1.3 Industrial scenario before and after AI.

AI is the study of agents, either softbots or robots that perceive the environment, think rationally and act accordingly like a human. In certain aspects, AI is the study to simulate the intelligence of humankind. AI aims to make machines observe and learn from people and solve problems or learn from the existing problem-solving techniques (McCarthy et al., 2006). Rather, AI is also involved in learning real-world problems which are highly challenging and finding novel solutions through experience. Researchers in AI are always instrumental in framing methods to solve highly complex problems beyond human ability and skill.

Even though humans made various innovations towards industrial and technological revolutions, human resources for such material production at different manufacturing units always poses a bigger challenge due to various factors such as financial constraints, inadequate manpower, human rights, etc. Hence, there is a dire need for these industries to move towards intelligent machinery and this intelligence injected in machines made another stepping stone in the industrial revolution also referred to as "*Artificial Intelligence.*" Thereby, the devices are expected to be knowledgeable about their input based on mechanical, statistical, and sensor-based inferences. In general, artificial intelligence can be defined as a "*machine with human intelligence to some extent.*" Below are given a few examples of machines with a limited level of intelligence.

- Washing machines used at home have a good level of decision-making and information communication systems based on the weight of clothes, type of clothes, and the space available inside the washing drum. Even the machine can detect salt deposition in the drum.
- Intelligent televisions learn from the viewing habits and patterns of the user and can make recommendations about movies, programs, or music. The AI televisions can be operated using voice commands and connected with other smart devices at home.
- A machine used to cut the wood for pencil can accurately cut and insert the needle and segregate the qualitative pencils from the damaged ones.
- An air conditioner is one of the daily use products that have the smartness to control its cooling based on the number of persons in a room, saving power.
- Mobile phones have automatic display control using ambient light sensor technology, which helps to adjust the display's backlight for smooth visualization of the displayed items.
- Devices used in the agricultural sector for humidity measurement and automatic water flow control and irrigation support system, etc.

Arthur R. Jensen, a foremost AI researcher, has expressed that all human beings possess similar logical and rational mechanisms but differ only on certain quantitative parameters such as short-term memory and the ability to store and retrieve information from their long-term memory, and the speed of processing. In contrast, computers can offer massive memory space and tremendous processing speed, but the application of their capabilities is much dependent upon the rational procedures built by the programmers. It is often told that cognitive science has not completely succeeded till now in defining human capabilities. People outperforming computers

always reveal the fact that the human who programmed the computers lack a clear understanding of the problem-specific and effective methodologies needed by computers.

Research in AI is always focused on the biological as well as the phenomenal aspects. The biological front is grounded on the impression that mankind is always intelligent and hence, studies in AI shall be on mimicking human psychology, behavior, and decision making. The phenomenal front is based on the study, formulation, and rational representation of the factual, worldly problems and the achievement of objectives by satisfying various real-world constraints. Both the approaches interact well and eventually work together towards progression in the field of AI.

1.3 HISTORY OF AI

Computing and intelligence are two significant words where most of us may have an identical understanding of these two words. A borderline differentiation between these two words will be helpful to have a better understanding of artificial intelligence. The word "computing" means performing any mathematical, logical, or relational operations, whereas intelligence by machine or artificial intelligence can be viewed as computing along with human intelligence. The concept of AI seems to be available since the 1940s, in various forms of intelligent computing models. The first intelligence-based computing method was introduced by the mathematician Alan Turing in 1947. He stated that more findings on machines' intelligence could be obtained by using computer programs and simulation than by using real machines. During the 1950s, most of the AI researchers have started working on computer programs rather than building machines. Turing has also discussed the circumstances to consider a machine as intelligent as a human. He strongly opined that any machine capable of mimicking and pretending as human to another human, then the machine can undoubtedly be considered as intelligent. This concept of testing machine intelligence, introduced by Alan Turing is referred to as the "Turing Test." Any machine that successfully completes the Turing test can be termed as intelligent, but an extraordinarily intelligent machine can always mimic humans even without knowing much about humans.

In 1956, John McCarthy, the researcher who actually founded the name "Artificial Intelligence" has presented his definition and views on AI in a conference at Dartmouth College, which paved the way for the beginning of the new era of AI research studies. Alan Turing had a perceptual visualization on future computing generation, which is also referred to as computing machines with thinking ability. The question challenged by Turing "Can Machine Think?" to the research community in the 1950s made a revolutionary change in the industry, which speaks on the transformation and modernization the world is now searching for in terms of Industry 4.0. Turing's concept made a strong foundation for AI, where several day-to-day applications have slowly started depending on the concept of artificial intelligence.

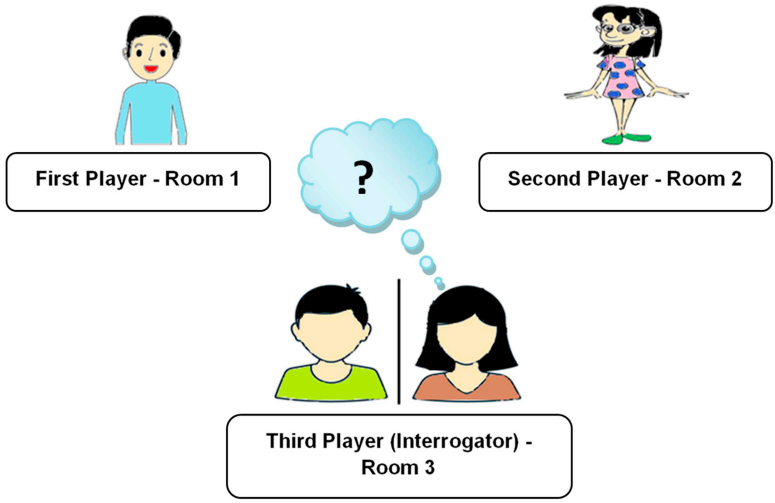

FIGURE 1.4 Party game scenario-I in turing test.

1.3.1 Turing Test

Turing proposed his concept through the game called "party test" which is also referred to as "imitation test" (Shieber, 2004). The basic concept of this game is to find whether the participant is a human or a computer. The test scenario-I consists of three players where the first player is a "man," and the second player is a "woman," and the third player is the "interrogator" who may be either a man or a woman. The first two players will be in two different rooms and the interrogator does not know who the players are. Now, the interrogator's challenge is to find the gender of the first two players based on the written answers given by them for the questions raised by the interrogator. Another challenge will also be created by making the first player intentionally give wrong answers to the questions, which may mislead the interrogator to infer that the first player is a "woman" instead of "man." Figures 1.4 and 1.5 show the two different test scenarios of the party game.

Turing has tried to project this game with a slight change, in which he replaced one of the first two players as a computer in test scenario-II. He tried to analyze whether the machine has the ability to act like a human player by applying its own intelligence. Turing has proven through the test that; the computer has a better ability to confuse the interrogator with its intelligence, so that the interrogator has the possibility to misinterpret the first player as human instead of the computer. Machine intelligence has been proven through Alan Turing's test and widely accepted by the research community. As a result, artificial intelligence began to have a strong influence in diverse domains. Several AI-based machines and applications came into the market, providing highly accurate results and a flexible environment to the users.

Richard Karp and Steve Cook have established the NP-complete problem theories in the late 1960s. These problems are solvable, but not in a finite time and take exponential time to obtain the solution when the problem size gets increased. Such

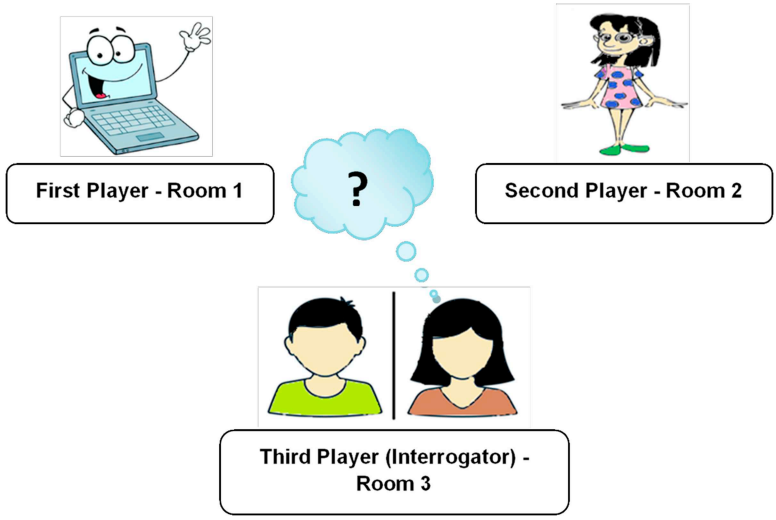

FIGURE 1.5 Party game scenario-II in turing test.

problem-solving difficulty faced in NP problem classes is termed as computational complexity. AI is expected to have capable algorithms for solving such highly computationally complex problems. However, the ultimate success in solving complex problems either by humans or by intelligent computer programs completely relies upon the specific attributes of the problems as well as the choice of suitable methods for solving the problems. It has always been a trial-and-error that could not be precisely identified by the AI research community and still remains an open challenge.

1.4 FOUNDATIONS OF AI

AI has inherited a variety of concepts, viewpoints, and practices from many other disciplines (Russell and Norvig, 2019). Learning and reasoning theories have emerged from philosophy, along with the notion that the operation of physical systems constitutes the functioning of the mind. The field of mathematics gave rise to the theory of computation, decision theory, logical reasoning, and probability. Psychology has presented investigative modes to study the human mind and systematically express the subsequent concepts. Linguistics gave the models about the structure as well as the meaning of natural languages. Above all, computer science gave the programming techniques to make AI a certainty. Likewise, various disciplines have made intellectual contributions to the fundamental theories and growth of AI.

1.4.1 Logic and Reasoning

Logic defines the knowledge to be possessed by the intelligent entity about the environment, the facts and proofs about the scenario in which the AI entity must

perceive and act, and its objectives denoted by certain mathematical terms. The intelligent program decides the appropriate actions be performed for achieving its objectives. Logic helps to represent worldly facts, and from the facts, other facts can be deduced, and certain inferences can also be drawn. Logic is one of the key aspects of critical thinking and decision making. Analogy and creativity are the other skills highly required in AI that helps to derive logic and to make the right decisions.

1.4.2 Pattern Recognition

Any intelligent system is generally trained to observe and compare related patterns to make observations and interpretations. For e.g., an intelligent vision program to identify a human face will try to match the face with facial features such as eyes, nose, and mouth, which form a regular pattern. More complex patterns, such as natural language texts, chess positions, paintings require highly precise and improved methods than the simple pattern matching, which gave rise to several studies on AI.

1.4.3 Cognitive Science

Cognitive science can be well defined as the multidisciplinary study of mind and intelligence, along with neuroscience, psychology, and philosophy. Model design and building, and carrying out experiments through computational techniques is the principal strategy of AI. In the domain of cognitive sciences, psychological experiments and computational prototypes ideally go in accord. Much more research works in AI are also investigating knowledge representation, cognitive systems, and psychology.

1.4.4 Heuristics

A heuristic is a rule of thumb, a trial method in discovering some idea that is embedded in the code. Heuristic methods are extensively used in Artificial Intelligence for fact-finding and decision making. These functions are also used in various styles to find possible solutions in a search space, for e.g., finding the distance of the destination node from the source nodes in the given search space. Heuristic functions can make comparisons among the feasible solutions and find the best optimal solution in problem-solving. The skill to explore and exploit exponential combinations of possible solutions is of utmost importance for an AI entity or program, like moves in a chess game. Research works are continuously carried out to determine how efficiently this search could be done in various domains.

1.4.5 Philosophy

AI can be associated with philosophy in many ways, particularly because both the disciplines study mind and common sense. The mind has a strong foundation of intellectual processing and realization, which stands inherent to the real world,

beyond rational understanding. Philosophy has instituted a customary practice where the human mind is perceived to be a machine predominantly operated by rational and cognitive abilities possessed within (McCarthy, 2006). It also explains the theories to establish the source of knowledge. Carl Hempel and Rudolf Carnap's philosophical concept tried to analyze the process of knowledge acquisition through experiential learning. Moreover, the association between knowledge and action is ruled by the mind and the modalities of specific associations and justifications for actions are the most needed research in AI. Thought processes, knowledge gain, and a sequence of reasonable actions play a huge role in modeling an intelligent agent that behaves rationally.

1.4.6 Mathematics

Mathematical validation in the areas of computation, logic, algorithm, and probability are much needed to formulate the theories of AI. In the 9th century, mathematician Al-Khowarazmi has introduced algebra, Arabic numerals, and formal algorithms for computation. In 1847, Boole introduced formal language for making a logical inference. AI has the responsibility to explore the abilities and limits of logic and computation. Further to logic and computation, Bayes probability theory and Bayesian analysis, have served as the foundation to the uncertain reasoning approaches in AI systems. There exist certain functions that can neither be computed nor be represented by formal algorithms. Alan Turing has also expressed that there were some functions that cannot be computed by Turing machine. There is a class of problems, termed as intractable, which says that when the size of the problem instances grows, there will be an exponential increase in the time taken to solve the problems in accordance with the instance size. Problem-solving through AI should pay attention to subdividing such problems into small subproblems and solving them in a reasonable time through intelligent behavior. The decision theory, established by John Von Neumann and Oskar Morgenstern in 1944, has provided the theoretical basis for most of the intelligent agent prototypes.

1.4.7 Psychology

William James in the 18th century opines that the brain plays a dominant role in acquiring, holding, and processing information, attributing to cognitive psychology. Craik stated that *"If the organism carries a 'small-scale model' of external reality and of its own possible actions within its head, it is able to try out various alternatives, conclude which is the best of them, react to future situations before they arise, utilize the knowledge of past events in dealing with the present and future, and in every way to react in a much fuller, safer, and more competent manner to the emergencies which face it."* He also specified the three key aspects of an intelligent agent as follows: i. Every *stimulus* should be linked to a specific form of representation, ii. the linked *representation* should be worked out by the cognitive processes to develop more representations, and iii. the set of representations are manipulated back to a set of associated *actions*. Information processing insights have started governing the field of psychology since 1960. Later on, psychologists

have believed that "*cognitive theories and computer programs work alike,*" which says that cognition consists of a well-defined transformation process operating through the information carried by the input. As per the early history of AI and cognitive science, researchers have treated Artificial Intelligence and psychology as the same discipline and it was quite common to view AI program behavior as psychological results. Nevertheless, the disparities in the methodology of AI and psychology were made clear at a later point of time, and clear-cut differences were identified between them, though they share and contribute a lot towards the development of each other.

1.4.8 Linguistics

Linguistics is termed the scientific and systematic way of studying languages, making observations, testing hypotheses, and making decisions. Noam Chomsky, in his book on *Syntactic Structures,* discussed the creativity in language and showed how young children comprehend and form a sequence of words that they were never familiar with. Chomsky's theory was based on the syntactic models and he has also suggested various programmable entities. Later developments in linguistics have highlighted more of the complexities and ambiguities in language studies. Linguistics not only speaks about the structure of sentences but also about the understanding of the subject matter and context, which has more to explore concerning AI and knowledge representation. Ontology is the field that studies the categories of existential objects. Computer programs mostly deal with many types of objects and their basic properties in AI. Many early works in AI were focused on language understanding for decision making, which has naturally created a link between AI and linguistics. These two fields gave rise to certain other hybrid areas of research such as computational linguistics and natural language processing.

1.5 THE AI ENVIRONMENT

The environment of artificial intelligence consists of five major components such as machine, Human Intelligence, Machine Learning (ML) algorithms, Internet of Things (IoT), Internet Of Everything (IOE), and Data Science and Engineering as shown in Figure 1.6.

The machine is a basic as well as an implicit component in both non-AI and AI-based environment. *Intelligence* is an interesting characteristic of a human that will discriminate humans from animals and even from another human as well. Identifying the best intelligence from human brains for finding a solution to the problem plays a major role in the AI environment. This intelligence will be embedded into the machine so that the machine will act as a smart machine by carrying human intelligence, in the form of a list of instructions also referred to as program or coding. Machine l*earning* is one of the efficient platforms which is used by most of the AI developers or AI programmers to produce intelligent coding. Machine learning algorithms play a major role, as they enable self-learning in AI entity from the environment and own experience. These algorithms are of much help in the

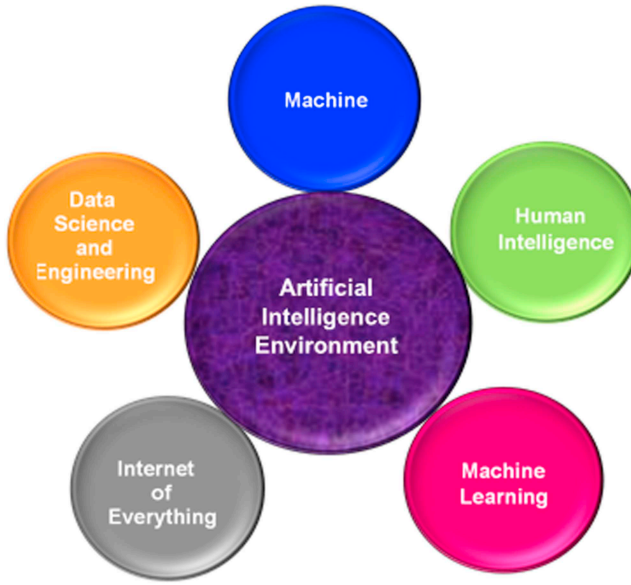

FIGURE 1.6 The AI environment.

prediction of events based on the available data and thereby forecast future trends. *Internet of Everything* and the *Internet of Things* has a very close relationship with the AI environment since most of the decision making will be depending on the real-time data produced by sensor technology. An intelligent program developed by the human in the form of coding will use the data acquired through various sensors connected to the AI environment. These data will help the machine to act intelligently so that the working environment becomes smarter. *Data Science and Engineering* is another important component in the AI environment. Data analysis plays an important role in most of the real-time applications since any decision making taken by the machine through programming majorly depend on efficient analysis of data. The integration of these components, but not limited to, will make an effective and AI environment.

1.6 APPLICATION DOMAINS OF AI

Globally, due to the immense developments and technological transformations in various sectors, the need for AI-based products and processes are on the rise even in everyday applications. Given the rapid advances in AI, it is more likely that pathology and radiology images will be analyzed by intelligent agents in the future (Whitby, 2008). AI agents in speech and text recognition are being employed for tasks like patient communication and recording of clinical notes. Figure 1.7 highlights the application domains of AI.

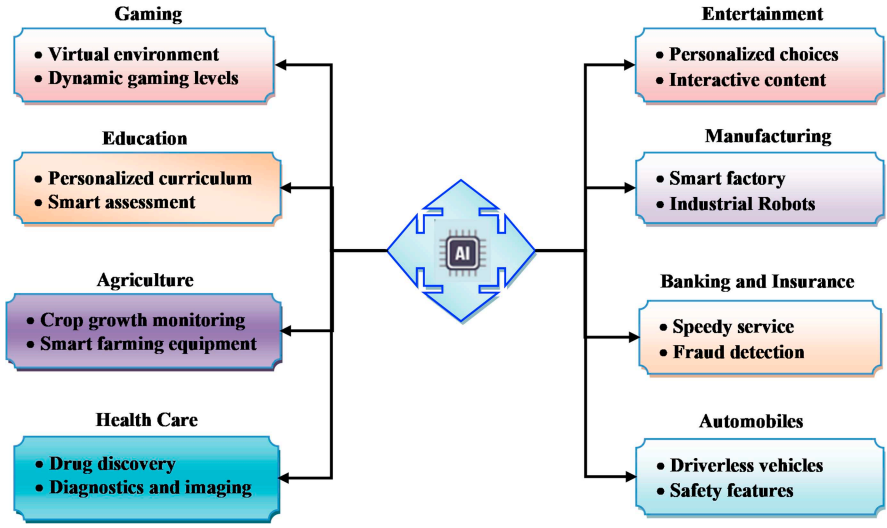

FIGURE 1.7 Application domains of AI.

1.6.1 Gaming

Artificial Intelligence in the gaming industry was dated back to the 1950s when Arthur Samuel released the Checkers game powered by AI, which successfully demonstrated the self-learning capability of computer programs. This program has given tough challenges to even professional players and could even win them on many occasions. Today, AI finds a significant place in game development, as games with AI provides a highly realistic feel and involvement to the users. Games are naturally complex and require a human mind to think in countless ways beyond imagination. Different users have different assumptions, different levels of understanding, different styles, and skills while playing games. The AI entity in gaming has to look into all these factors, train itself by taking into consideration various human perspectives, and set nearly infinite strategies to tackle the human opponents. The AI program gains knowledge and learns a lot from each and every user playing the game. It creates a huge knowledge base of reference, which gets updated with every new game played and aids in making dynamic decisions during the game. Regression algorithms and machine learning techniques go hand-in-hand in predicting the game moves of the human opponent. The gaming industry provides a risk-free virtual environment for testing the intelligence of AI applications and enables us to explore creativity without any restrictions, though challenging.

1.6.2 Education

AI has a greater potential to change the teaching-learning process, assist teachers in devising better strategies in teaching, assist students in an adaptive and improved learning experience. AI can automate the administrative responsibilities of teachers

and academic institutions. Extensive research and development works are being carried out to develop intelligent educational tools, which could save teachers time by assisting them in the maintenance of student attendance, evaluation of exam papers, assessment of assignments, and other supportive activities in education. AI in education is much focussed on identifying the subject knowledge and learning capability of each and every student through investigative testing and to develop personalized and student-specific curriculum. AI can be of much help in supporting the students who struggle to cope up with the common curriculum and combined teaching-learning practices.

Personalized learning experiences are expected to overcome the major shortcomings in the classic one-to-many educational models. Inclusive learning will become a reality with AI, where students from varied educational and societal backgrounds can participate in a classroom lecture and effectively engage in discussions. It is always a myth that the introduction of AI in education will lead to a replacement of teachers, but the actual fact is that teachers will be enabled through AI to perform better by providing individual attention and personalized recommendations to every student. AI can also customize the student assignments and exam question papers as well, thereby assuring a better environment for the students. Educational AI applications will facilitate students to learn in a conducive way, and the growth in this area will offer a wide range of prospective services to teachers and students.

1.6.3 Healthcare

AI technology is revolutionizing the medical sector and offers multiple advantages over traditional analytics and medical decision-making practices (Yu et al., 2018). It can assist doctors and scientists in early detection and prevention of diseases, suggest personalized treatment plans for patients, unlocks various complex data sets to gain new understandings. Intelligent algorithms in AI can speed up and improve the precision in the analysis of medical data and images, which will allow physicians to gain more insights into disease diagnosis, treatment decision, and patient care. Automation of medical procedures through AI can expand healthcare access to millions of people who live in remote or underdeveloped regions where there is a shortage of trained medical as well as paramedical professionals. AI systems can also be used in taking X-rays, ultrasound, CT and MRI scanning, and many other diagnostic procedures which are in general performed by clinical support staff. AI and machine learning algorithms are capable to speed up the analysis of huge medical data, arrive at some meaningful inferences through predictions, provide early alerts about patient health conditions, recommend and support doctors in making decisions on the treatment to be given for critically ill patients. Artificial Intelligence (AI), combined with investigational technologies, is estimated to pave the way for the discovery of cost-effective, improved, and more successful drugs for various health complaints and diseases. AI will be helpful to automate and optimize the research and development in drug discovery procedures.

1.6.4 Agriculture

AI-assisted technologies can support the agricultural sector in improved crop yield, pest control, soil nutrition monitoring, crop growth monitoring, and many other tasks related to agriculture. AI can help the farmers to monitor their crops without the requirement to personally supervise and observe the farm. AI is changing the traditional agricultural practices, reduce the burden of farmers, and improve crop management. AI can also be utilized to test soil nutrient availability, nutrient deficiency, and other defects in the soil. This will enable the farmers to limit the use of chemical fertilizers as per the nature of the soil and crop needs. Implementing AI can also check crop defects and diseases at an early stage, thereby improving healthy crop production and controlled pesticide usage. AI-enabled applications are highly supportive of the farmers in forecasting the weather conditions, which play a vital role in crop planning and cultivation. Weather data also assists the farmer to take the precautionary steps to protect the crops based on the predicted rainfall or drought, with the help of AI. Furthermore, AI helps farmers to selectively identify the weeds, which helps to spray chemicals only on the weeds without affecting the crops. Implementing AI in agriculture will strengthen the agricultural sector to a remarkable extent and reduce the work of farmers by providing accurate and timely guidance.

1.6.5 Entertainment

Artificial intelligence serves as a powerful tool in the entertainment industry, bringing massive changes and thus reshaping the entertainment arena. AI along with augmented reality, data analytics, and deep learning technologies exhibit remarkable intelligence in interactive game design, innovative content production, movie design, and advertisement creation. AI has brought in an innovative style, creativity, and reality to content creation, delivery, and re-defined consumer engagement. In movie creation, AI employs massive data sets to analyze and explore the user preferences and to design scenarios, far beyond human capabilities. Various learning strategies are used by AI to learn from all possible external knowledge sources and self-experience to design interesting content. Companies use AI to monitor customer activity, assess customer behavior and to analyze customer sentiments on products, and use this analysis in improved as well as personalized service provisioning.

1.6.6 Manufacturing

Industry 4.0 is focused on bringing out a massive transformation in the manufacturing industry where Artificial intelligence serves as a core component in this revolutionary process. Artificial Intelligent technologies are capable of making the concept of "*Smart Factory*" a reality, which makes more productivity as well as staff empowerment. Andrew Ng, the co-founder of Google Brain and Coursera, says: "*AI can efficiently accomplish manufacturing, ensure quality control, reduce the design time, cut down materials wastage, further production recycling, and*

reuse, do predictive maintenance, and much more". Starting from materials procurement, production, warehousing to supply chain, sales, and maintenance, AI is aimed at changing the way every industry operates so far. The International Federation of Robotics has predicted that by 2025, there will be around 1.5 million industrial robots working in factories worldwide (Gonzalez et al., 2018). As more and more robots enter into the industrial shop floor along with human workers, there is a need to ensure efficient collaboration between robot and human. Advances in AI will enable robots to optimize industrial processes, handle more cognitive tasks, and make dynamic decisions based on the real-time scenario. AI algorithms play a significant role in the estimation of market demand, location and economic factors, weather patterns, consumer behavior, and much more.

1.6.7 Banking and Insurance

Artificial intelligence has gifted the banking and the insurance sector a whole new system to meet the customer demands with more convenient, smart, and safe methods to protect, spend, save, and invest their money. Artificial Intelligence will be the forthcoming trend in the banking sector as it is powered by the ability of data analytics to improve compliance, derive valuable insights, and tackle fraudulent transactions. AI can make use of the humongous data available in the insurance sector for more accurate predictions, determine trends, risks, save manpower, and ensure better information for future planning. An intelligent algorithm could realize anti-money laundering activities in no time compared to the time and effort to be spent by human resources. AI bots, digital payment consultants, and biometric fraud detection devices will reduce costs, ensure accurate and quick processing in banks, and offer highly improved quality of services to the customers. AI bots can instantly detect suspicious activities and security breaches concerning customer accounts and can alert the customers and companies well before the occurrence of fraud. Repetitive work processes can be automated, which allows human knowledge and time to be used for value-added functions, which definitely needs human expertise.

1.6.8 Automobiles

As autonomous vehicles are going to be the future, Artificial Intelligence is getting implemented in numerous ways in the design and operations of vehicles. Artificial Intelligence and machine learning have been successfully applied in the navigation of vehicles, monitoring of blind-spot, seats, mirrors, and temperature adjustment, and also in giving personalized suggestions. Various sensors controlled by AI can immediately respond to any dangerous situations by alerting the driver, applying the automated emergency braking system, or taking control of the vehicle and initiating communications to helplines. AI enables the detection of technical changes well in advance before it could affect the vehicle's performance and helps prevention of unexpected failures. Automated Guided Vehicle (AGV) is another path-breaking technology in the automobile industry, powered by AI. Without any human assistance, AGVs can identify the objects, find the optimal routes, pickup, and deliver goods to different parts of a designated location. Recently, many AI techniques are

being tested and implemented in automobiles, aiming towards more effective automation and a driverless future.

1.7 AI TOOLS

Artificial Intelligence tools support the development of AI solutions for real-time, complex problems found in a variety of application domains. These tools have built-in functions and algorithms that help the user to analyze the nature of the problem, design a flexible prototype, build multiple solutions, test them and identify the best optimal solution within a very short time period. The tools can also simulate cognitive functions such as experiential learning, reasoning with logic, environmental sensing, and social intelligence like that of the human mind. Table 1.1 lists some of the successful tools in Artificial Intelligence and machine learning.

1.8 CHALLENGES IN AI

Like any technological developments, Artificial intelligence has both positive as well as negative impacts. Even though AI has a huge potential to serve mankind, there are certain challenges to be faced in real-time implementation (Harkut and Kasat, 2019). The following section discusses the major challenges of artificial intelligence in the working environment. Figure 1.8 shows the challenges of AI technology concerning various factors which include human bias, manpower, security, data genuineness, etc.

1.8.1 Loss of Self-Thinking

The intelligence of one person may make a machine to behave smart and intelligent subject to the person's knowledge who feed intelligence to the machine. It does not mean that this constrained machine intelligence will enhance the user's self-thinking ability. Instead, this kind of someone else's intelligence may lead to negative impacts as well. For instance, a machine having limited intelligence in decision making will make a human to follow it as such, though there may be better decisions that could be arrived by the human by their own intelligence.

For example, consider the scenario in which a machine having the intelligence to segregate the materials based on the color property. Assume the materials are in three different colors such as red, blue, and green and there are also other materials with a combination of the above three colors. The machine can perfectly segregate the materials with identical colors, but materials with composite colors and fading colors may be identified only through the program using color thresholding and this color thresholding is mostly static and user-defined. Sometimes, a human can do better segregation of color material than a machine that uses static intelligence. Such failure cases by intelligent machines are referred to as *false positives* and *false negatives*. Figure 1.9 shows the general representation of identical colors and degrading colors where the machine and human will be discriminated against in terms of their own intelligence.

TABLE 1.1
Tools in AI

Tool	Purpose	Website
Analyst	AI tool to analyze and organize unstructured data into a general set of rules to facilitate detailed AI and ML structures.	https://www.analyst-toolbox.com/
Tensorflow	Python-based AI library that provides diverse functionality to implement Deep Learning Models.	https://www.tensorflow.org/
ML Kit	Mobile-only SDK, which embeds machine learning technologies for face and text recognition, barcode scanning, image labeling, etc.	https://firebase.google.com/products/ml-kit
H2O	Deep learning AI platform for predictive modeling, risk analysis, insurance, advertising, healthcare, and customer intelligence.	https://www.h2o.ai/
Pytorch	An open-source AI and machine learning tool to accelerate research prototyping towards product deployment	https://pytorch.org/
DeepChem	A python-based AI tool for drug discovery, materials science, quantum chemistry, and biology.	https://www.deepchem.io/
scikit	AI tool for data pre-processing, predictive data analysis, model fitting, model selection, and evaluation	https://scikit-learn.org/stable/
DeepTox	AI tool that predicts the toxicity of chemical compounds	http://www.bioinf.jku.at/research/DeepTox/
Keras	AI tool for fast prototyping, configuring networks, and image recognition	https://keras.io/
Rainbird	AI tool for intelligent automation and decision making in finance, healthcare, insurance, and banking services	https://rainbird.ai/
AutoAI	AI tool that analyzes the dataset and discovers problem-specific data transformations, algorithms & parameter settings, builds and deploy a machine learning model	https://dataplatform.cloud.ibm.com/docs/content/wsj/analyze-data/autoai-overview.html

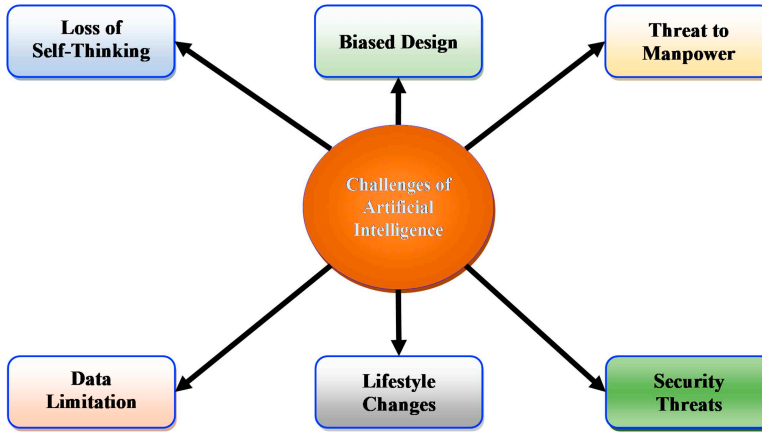

FIGURE 1.8 Challenges in AI.

FIGURE 1.9 Representation of solid colors and composite colors.

1.8.2 Bias in the Design of Artificial Intelligence

The question *"Will it be a better model when one person's knowledge is adopted by all others?"* is a great challenge for artificial intelligence developers. The answer to this question will make us understand the influence of "*bias*" in the design of artificial intelligence. Any machine designed with human intelligence and algorithms is primarily dependent on either the knowledge of a single person or a specific group and hence, the machine intelligence will be restricted based on their limited knowledge. This intelligence can be manipulated and controlled by the developer, which may not be favorable to all scenarios. This bias in design may become a threat to society to forcibly adopt a model, though it is not a perfect fit for everyone.

1.8.3 Limitation on Data

Availability of data plays a major role in justifying the performance metrics of any AI entity. Genuineness of the data is another major challenge to the developers of artificial intelligence as well as to the AI researchers. Most of the AI-based outcomes are primarily based on existing, dynamic data being continually collected. Several data pre-processing algorithms developed by researchers are available to smooth the data before developing any intelligence model. Now the question before AI developers is "*How to find and fill up the missing data?*" In general, AI developers will use mathematical and statistical models such as interpolations, regression, and correlation methods for fitting missing values with respect to existing data. These predicted and fitted values show higher influence in artificial intelligence models. The second question is "*Will the mechanism used by AI developers for selection and rejection of data is perfect and suitable to all?*" Figure 1.10 shows two different ways to cluster the data points, a simple illustration of two possible ways to construct AI models. In the first method, lower-right data points were considered and upper-left data points were excluded whereas in the second method, upper data points were selected and lower data points were excluded. Hence, the development of AI models based on these two methods will surely give two different kinds of understanding based on the corresponding selection of data.

1.8.4 Threat to Manpower

The goal of artificial intelligence is to reduce human errors by replacing them through machine intelligence. Job opportunities will be limited due to the growth and development of human free artificial intelligence models in society. This reduction in job opportunities due to the development of AI will indirectly influence the economy, as artificial intelligence gradually reduces manpower (McCarthy, 2000). Worldwide population growth is always on the rise, and hence the development of humanless technology may pose a big threat to human survival irrespective of the country. Figure 1.9 shows the influence of robots replacing manpower in an industrial environment.

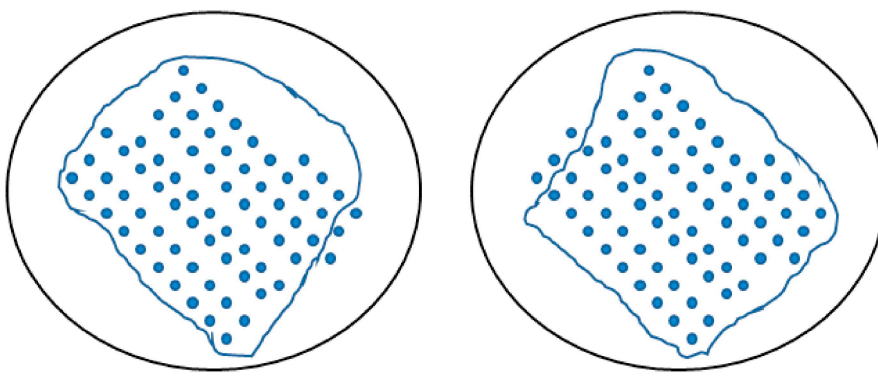

FIGURE 1.10 Two different types of clustering data to build AI model.

1.8.5 Lifestyle Changes

The current lifestyle of the human being is incomparable with the traditional lifestyle due to the extensive use influence of technology. Technological development is also playing its own role as one of the factors which are affecting the health of the human being. For example, most of the traditional games were replaced by technology-based games where there is no physical exercise to the human. Some AI-based games are highly interesting not only to young children but also to old age people, where unknowingly their mind and brain are affected and addicted to the games. It is another big challenge where the users undergo immense stress and struggle to come out of the virtual environment, especially the younger generation.

1.8.6 Security Threats

AI has placed its footprints all over the world in smart product development and an integrated environment. The integrated environment will help society to access AI-based products from any corner of the world but on the other side, there is always a standing threat by intruders to do unauthorized access to these AI-based products. This leads to a major threat to society, as the intruder may get access and alter the functionality of the AI products. Think about the scenario where the AI machine designed to detect and remove the "weed" in the crop field starts to remove the crop instead of weed due to security malfunctioning. Such hidden threats are always there in most of the AI-based developments.

1.9 FUTURE PROSPECTS OF AI

AI is one of the significant and powerful breakthroughs which will have a huge impact on human in all walks of life and hence it needs continuous monitoring and attention to frame standards and policies for the upcoming years. Though initial efforts in AI is highly challenging, AI is expected to master all the domains in the future. The emphasis of AI should not only be on the capability of the technologies, but also the usefulness and implementation in the respective field. AI will undoubtedly empower the automation industry through a vast knowledge base and also infuse a high level of intelligence into the entire automation process, which will assist to prevent the associated cyber threats and contention.

AI will become integral to all processes and operations and keeps evolving and innovating with time without considerable manual intervention. For widespread adoption of AI systems, regulations and standards must be set up by the competent authorities, provision for integration must be made available, sufficient training and knowledge must be given to the user base to make them clearer about their roles and the role of AI systems. Above all, the AI system must be constantly updated and to be incorporated with day-to-day advancements in the field (Cio et al., 2020). Future developments in AI has to be more focused on bias-free, eco-friendly, non-radioactive, carbon-neutral, and energy-efficient AI environment. Figure 1.11 presents the current scenario of manufacturing units, where robots assist humans in

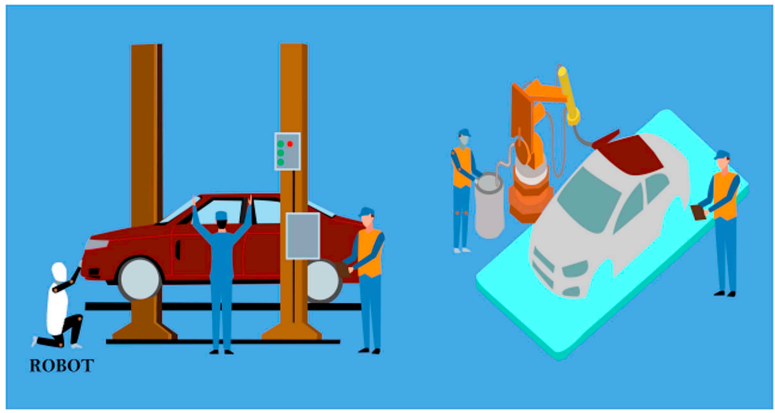

FIGURE 1.11 Present scenario of manufacturing unit.

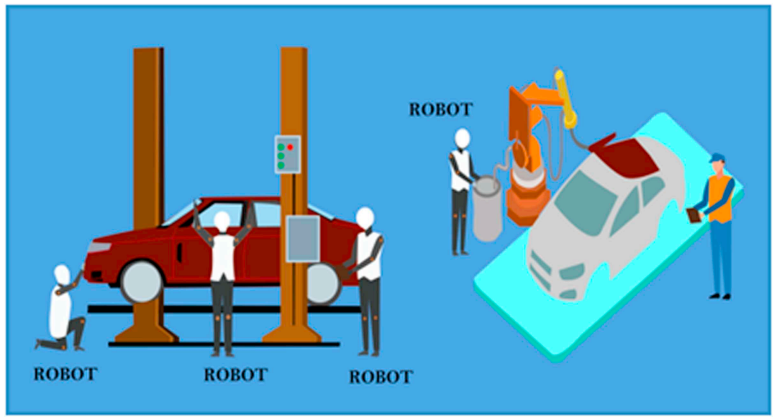

FIGURE 1.12 Future scenario of manufacturing unit.

their work. Figure 1.12 shows the future scenario, where robots carry out the entire work under human supervision.

1.9.1 Applicability

Artificial intelligence models are being developed with the available, limited data based on few assumptions. Applying and testing the AI prototype to similar applications may result in similar results and interpretation. Also, applying the same prototype for slightly varied applications may not ensure proper decision making in all cases. Hence, the development of a flexible AI model to fit global requirements will be the focus in the future for AI developers.

1.9.2 Dynamism in AI Model

Most of the AI applications are developed for the current technologies which keep updated on an everyday basis. Hence, an artificial intelligence–based system developed with today's capability may not be suitable in the future due to the dynamic change and growth in technology (Oke, 2008). Scalability in terms of functionality with respect to the current requirements is another bigger challenge for AI designers. All the AI models developed based on the present scenario should also have the ability and adaptability to support future scenarios.

1.9.3 Economic Feasibility

The cost factor involved in the development of AI models is huge and not affordable by many. Even though introducing AI in a work environment have many positive footprints, the cost involved in developing and implementing such automated environments may not be economically feasible when compared with a traditional working environment. Hence, introducing this technology in small-scale industries and its applications may not be in the position to implement the same due to the higher influence of cost factor. More works are to be done in bringing down the cost incurred in the development and maintenance of AI systems.

1.9.4 User Training

Transformation in the workplace requires the user to have preliminary knowledge as well as intense training on AI models. Training on AI technology either before launching or after launching the AI products is mandatory to the user for effective usage of the AI system. For example, intelligent word editors and text-based applications can continue the word or subsequent words when the user tries to type half of the word itself. This word predictive and suggestive system needs a minimal level of training to the user for selecting such predictive words or sentences by pressing corresponding keys. Some users do not even know how to use such word applications even though users are using the word applications in their day-to-day working environment.

1.10 SUMMARY

AI plays a highly significant and responsible role in society and of late, notable advancement has been made in this domain. AI is always a matter of interest in generating new ideas and innovative products that can adapt and maneuver the complex thought process of humans. AI has the potential to make human life comfortable and easy in several aspects. On the industrial front, AI can make wonders by incorporating intelligent bots in production, which have the power to perform tasks at an unimaginable speed with much precision as well. Many research and development works are going on worldwide to bring down the initial investment cost incurred in this industrial transformation.

This chapter has highlighted how effectively AI can be applied in various application domains such as healthcare, education, automobiles, entertainment, and so on. There is no doubt that the future is going to be AI-centric, where there will be intelligent robots all around us, carrying out a variety of automated tasks and helping mankind. On the other end, any technology is like a double-edged sword and AI is no exception to that. A time may come when smart machines will overpower the human race and will slowly make us all completely dependent on the comfort and luxury provided by artificially intelligent entities. Regulations and standards are to be framed to ensure the role of AI, invariably the intelligent machine or robot, as rightly pointed by Isaac Asimov in 1942, as given below (Barthelmess and Furbach, 2014).

- *A robot may not injure a human being or, through inaction, allow a human being to come to harm.*
- *A robot must obey the orders given to it by human beings, except where such orders would conflict with the First Law.*
- *A robot must protect its own existence as long as such protection does not conflict with the First or Second Laws.*

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