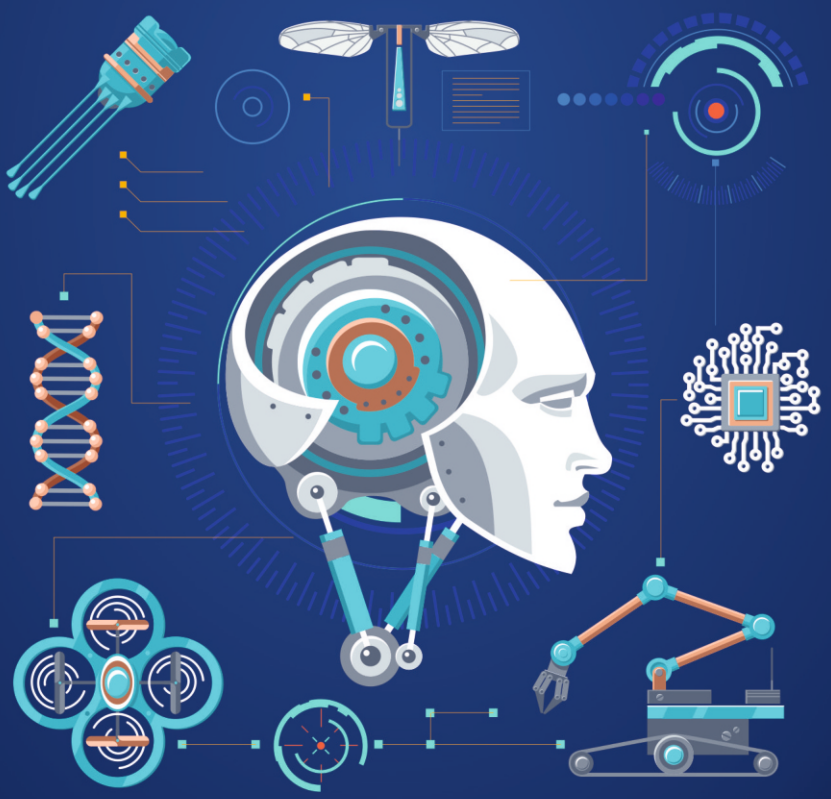
DEEP MACHINE LEARNING

V.K. Jain



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Deep Machine Learning

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Published by :
Romesh Chander Khanna & Vineet Khanna
for KHANNA PUBLISHERS
2-B, Nath Market, Nai Sarak
Delhi- 110 006 (India)

Website : www.khannapublishers.in

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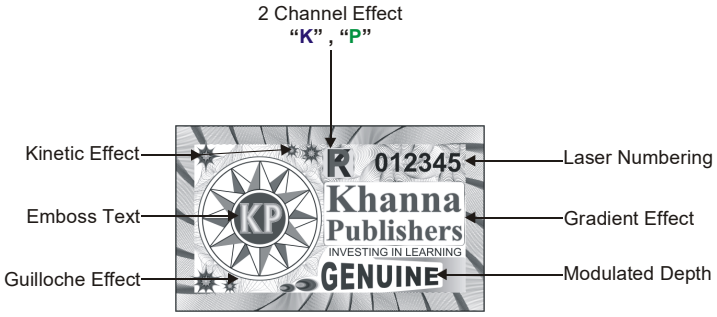

ISBN No. : 978-93-92549-48-9

First Edition : **2024**

Price **: Rs. 369.00**

Preface

There is a growing misconception that deep learning is a competitive technology to the machine learning domain. To put things in perspective, deep learning is a subdomain of machine learning. With accelerated computational power and large data sets, deep learning algorithms are able to self-learn hidden patterns within data to make predictions.

In its nascent years, artificial intelligence (AI) focused heavily on rule-based systems that would make predictions using predefined sets of rules that had to be provided by a subject matter expert. However, these systems were brittle and relied on these "expert opinions," which eventually caused them to fall out of fashion. As the scale and amount of data increased, these methods were replaced by a more data-driven approach, machine learning.

The magic of deep learning starts with the humble perceptron. Similar to how a "neuron" in a human brain transmits electrical pulses throughout our nervous system, the perceptron receives a list of input signals and transforms them into output signals.

The first trainable neural network, the Perceptron, was demonstrated by the Cornell University psychologist Frank Rosenblatt in 1957. The Perceptron's design was much like that of the modern neural net, except that it had only one layer with adjustable weights and thresholds, sandwiched between input and output layers.

The first serious deep learning breakthrough came in the mid-1960s, when Soviet mathematician Alexey Ivakhnenko created small but functional neural networks.

Machine learning algorithms are also preferred when the data is small. Instances where deep learning becomes preferable include situations where there is a large amount of data, a lack of domain understanding for feature introspection, or complex problems, such as speech recognition and NLP.

But lately, Deep Learning is gaining much popularity due to it's supremacy in terms of accuracy when trained with huge amount of data.

I had provided Sufficient matter in this book for reader to get jobs and work in field as Data Scientist, Data Analyst, Data Architect, and NLP Scientist.

A vast amount of literature and textbooks are available in India, but they are mainly concentrated on subjects of machine learning which were taught at-least two decades ago. (2023).This book deals with the modern courseware including deep learning, generative, discriminative and inductive learning also.

I have a great sense of gratitude toward my publisher trio, Kratu, Akshita and Budhesh Khanna, their father and grandfather. These *panch mahanubhav* not only gave me the startup in technical writing but very firmly established me as an author.

—V.K. Jain

Contents

Module 1

Machine Learning

1.1. ARTIFICIAL INTELLIGENCE (AI) AND MACHINE LEARNING

Artificial intelligence (AI) was one of the key disruptive technologies that was singled out to watch out for in 2018. AI is emerging as one of the most promising technologies that will help deliver services like healthcare and enable financial inclusion faster, more effectively and efficiently, to a higher number of consumers and finally at lower cost. Big data is the foundation of AI—the large base of structured and unstructured content being the fodder that enables AI to learn and continue learning and come up with not just predictive but prescriptive analysis.

According to a recent global report by Teradata, the industries where respondents expect to see the most impact from AI are IT, technology and telecom (59 percent), business and professional services (43 percent), and customer services and financial services (32 percent).

The most significant change in Data Science is (as in 2018) is likely to be the mainstreaming of big data and the increased uptake of machine learning.

As the Fig. 1.1 shows Machine learning is a part of Artificial Intelligence (AI).

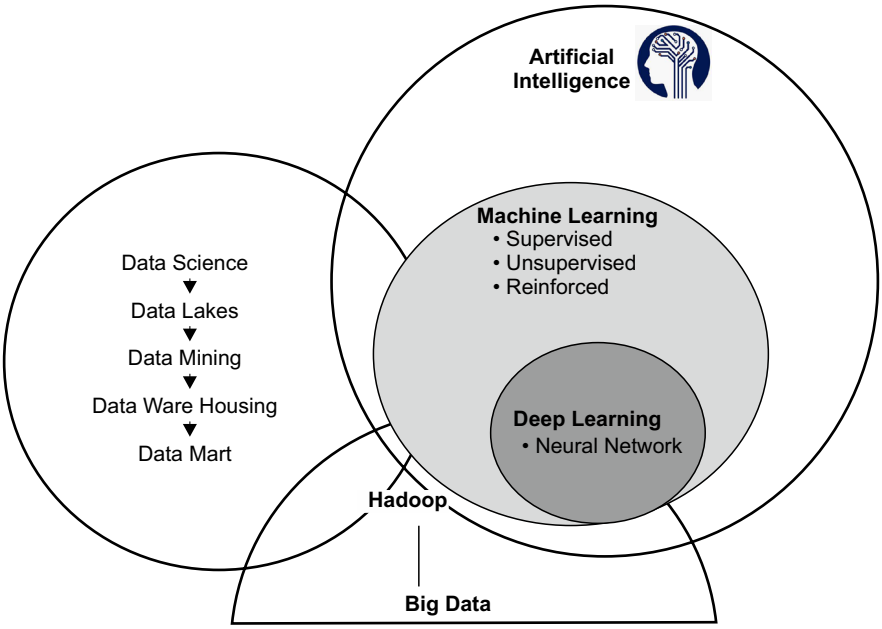

Fig. 1.1. Machine learning is a part of Artificial intelligence (AI).

The science of Machine Learning has taken over the field of AI as machines are exposed to myriad data sources to make predictions. "We can train neural networks for a lot of different kinds of inputs and different kinds of outputs". We can run any picture through the model and it can give predictions. We can take a sequence of audio features and transform it to speech recognition. These are quite complicated functions that systems can learn.

Since then, Google has been running ML on different data sets — from tracking seacows to diagnosing diabetic retinopathy and other health challenges.

There are 6,000 languages globally and 400 of them have over a million speakers. The effort is to bring more global languages online. Google is focusing on strengthening its AI talent pool. It had over 1,000 engineers trained in ML in 2012, but the number has risen sharply to 18,000 today.

1.2. MACHINE LEARNING

Machine learning is a branch of **Artificial intelligence (AI) learning** science that deals with programming the systems in such a way that they automatically learn and improve with experience. Here, learning means recognizing and understanding the input data and making wise decisions based on the supplied data.

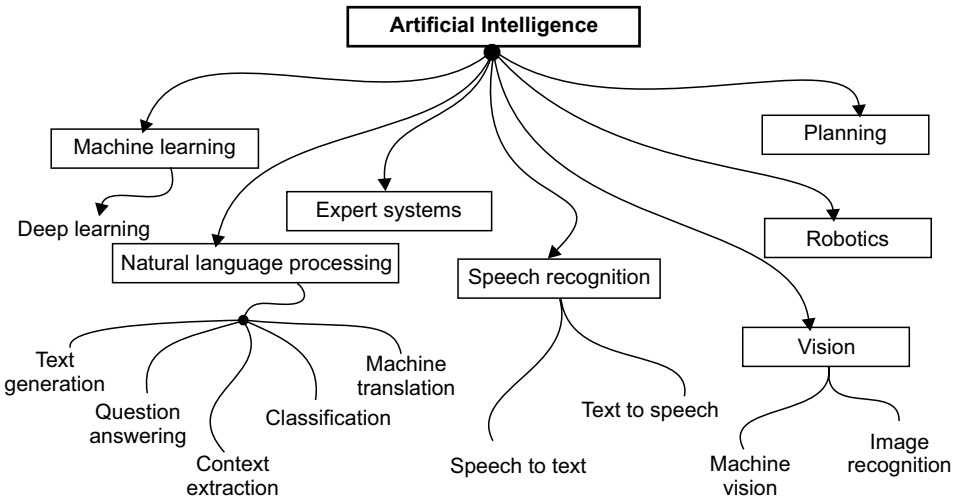

Fig. 1.2. Components of Artificial Intelligence.

1.2.1. Machine Learning for data Analysis

Machine learning is a subfield of computer science that deals with tasks such as pattern recognition, computer vision, speech recognition, text analytics and has a strong link with statistics and mathematical optimization. Applications include the development of search engines, spam filtering, Optical Character Recognition (OCR) among others. The boundaries between data mining, pattern recognition and the field of statistical learning are not clear and basically all refer to similar problems.

Figure 1.3 makes the classification more clear to understand.

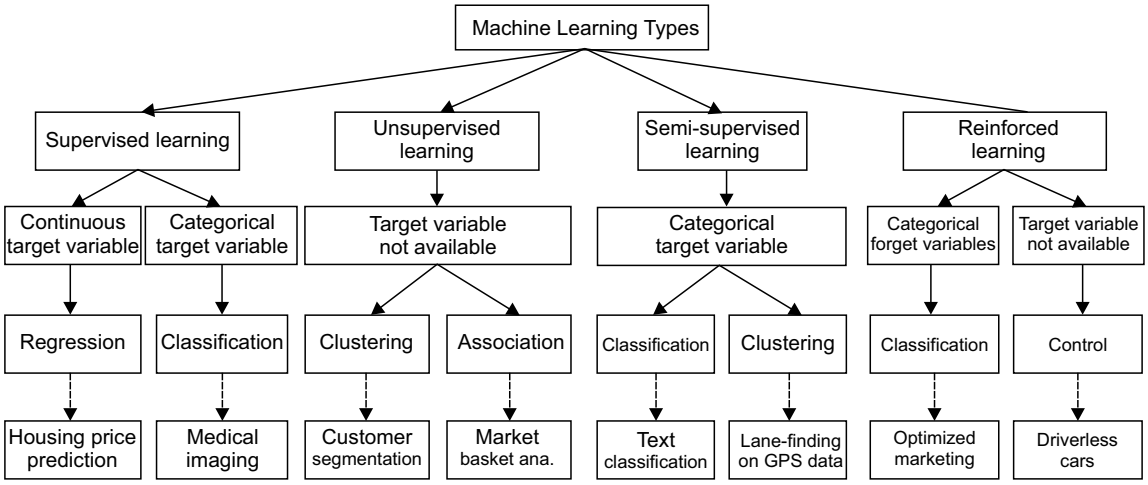

Fig. 1.3. Details of the application area of three branches of Machine learning methods.

It is very difficult to cater to all the decisions based on all possible inputs. To tackle this problem, *algorithms* are developed. These algorithms build knowledge from specific data and past experience with the principles of statistics, probability theory, logic, combinatorial optimization, search, reinforcement learning, and control theory.

Machine learning is said to be a method of data analysis that automates analytical model building. It is a branch of artificial intelligence based on the idea that machines should be able to learn and adapt through experience.

However this diagram also does not provide complete arena of Learning process covered by Machine learning currently (2022) and details of recent learning methods are provided in section 1.8 of this module.

1.3. EVOLUTION OF MACHINE LEARNING

Today, machine learning algorithms enable computers to communicate with humans, autonomously drive cars, write and publish sport match reports, and find terrorist suspects. Humanity made this possible after almost 80 years' efforts by many scientists from all over the world.

The following are the extracts from the article "A Short History of Machine Learning — Every Manager Should Read" written by Bernard Marr in Forbes Magazine.

1950 — Alan Turing creates the "Turing Test" to determine if a computer has real intelligence. To pass the test, a computer must be able to fool a human into believing it is also human.

1952 — Arthur Samuel wrote the first computer learning program. The program was the game of checkers, and the IBM IBM +0% computer improved at the game the more it played, studying which moves made up winning strategies and incorporating those moves into its program.

1957 — Frank Rosenblatt designed the first neural network for computers (the perceptron), which simulate the thought processes of the human brain.

1967 — The "nearest neighbor" algorithm was written, allowing computers to begin using very basic pattern recognition. This could be used to map a route for traveling salesmen, starting at a random city but ensuring they visit all cities during a short tour.

1981 — Gerald Dejong introduces the concept of Explanation Based Learning (EBL), in which a computer analyses training data and creates a general rule it can follow by discarding unimportant data.

1990s — Work on machine learning shifts from a knowledge-driven approach to a data-driven approach. Scientists begin creating programs for computers to analyze large amounts of data and draw conclusions — or "learn" — from the results.

1997 — IBM's Deep Blue beats the world champion at chess.

2006 — Geoffrey Hinton coins the term "deep learning" to explain new algorithms that let computers "see" and distinguish objects and text in images and videos.

2010 — The Microsoft MSFT Kinect can track 20 human features at a rate of 30 times per second, allowing people to interact with the computer via movements and gestures.

2011 — IBM's Watson beats its human competitors at Jeopardy.

2011 — Google GOOGL Brain is developed, and its deep neural network can learn to discover and categorize objects much the way a cat does.

2012 – Google's X Lab develops a machine learning algorithm that is able to autonomously browse YouTube videos to identify the videos that contain cats.

2014 – Facebook FB develops DeepFace, a software algorithm that is able to recognize or verify individuals on photos to the same level as humans can.

2015 – Amazon launches its own machine learning platform. Microsoft creates the Distributed Machine Learning Toolkit, which enables the efficient distribution of machine learning problems across multiple computers.

2015 – Over 3,000 AI and Robotics researchers, endorsed by Stephen Hawking, Elon Musk and Steve Wozniak (among many others), sign an open letter warning of the danger of autonomous weapons which select and engage targets without human intervention.

2016 – Google's artificial intelligence algorithm beats a professional player at the Chinese board game Go, which is considered the world's most complex board game and is many times harder than chess. The AlphaGo algorithm developed by Google DeepMind managed to win five games out of five in the Go competition.

2017 – Waymo started testing autonomous cars in the US with backup drivers only at the back of the car. Later the same year they introduce completely autonomous taxis in the city of Phoenix.

2020 – Facebook introduced a chatbot that was able to converse on a wide array of topics

2020 – Open AI announced a ground-breaking natural language processing algorithm GPT-3 with a remarkable ability to generate human-like text when given a prompt. Today, GPT-3 is considered the largest and most advanced language model in the world, using 175 billion parameters and Microsoft Azure's AI supercomputer for training.

Because of new computing technologies, machine learning today (2022) is not like machine learning of the past. It was born from pattern recognition and the theory that computers can learn without being programmed to perform specific tasks; researchers interested in artificial intelligence wanted to see if computers could learn from data. The iterative aspect of machine learning is important because as models are exposed to new data, they are able to independently adapt. They learn from previous computations to produce reliable, repeatable

DEEP MACHINE LEARNING

About the Book

This book, explains modern methods under Deep Machine Learning. Once an academic field now a disruptive technology, deep learning is still evolving. In this volume, the major focus is on the theory and algorithms under Deep Machine Learning, particularly important for understanding the basic concepts.

Intended for engineering professionals, every learner will find this book as an essential reference to get an industry perspective. This book is also rich in discussing different applications in order to give the practitioner a flavor of how Deep Machine Learning methods works for different problems. In this volume, Er. V.K. Jain offers detailed introduction to the modern methods demystifying Deep Machine Learning providing an insight of the areas such as Artificial Intelligence, Supervised and Unsupervised Learning, Speech Recognition, Reinforcement Learning and other fundamental concepts and techniques.

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