

# Advanced Algorithms And Parallel Programming *Theory*

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## Abstract

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# Contents

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<b>1</b>	<b>Deep learning</b>	<b>1</b>
1.1	Introduction . . . . .	1

# CHAPTER 1

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## Deep learning

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### 1.1 Introduction

**Definition** (*Machine Learning*). A computer program is considered to learn from experience  $E$  with respect to a specific class of tasks  $T$  and a performance measure  $P$  if its performance at tasks in  $T$ , as measured by  $P$ , improves with experience  $E$ .

Given a dataset  $\mathcal{D} = x_1, x_2, \dots, x_N$ , Machine Learning can be broadly categorized into three types:

- *Supervised Learning*: in this type of learning, the model is provided with desired outputs  $t_1, t_2, \dots, t_N$  and learns to produce the correct output for new input data. The primary tasks in supervised learning are:
  - **Classification**: the model is trained on a labeled dataset and returns a label for new data.
  - **Regression**: the model is trained on a dataset with numerical values and returns a number as the output.
- *Unsupervised Learning*: here, the model identifies patterns and regularities within the dataset  $\mathcal{D}$  without being provided with explicit labels. The main task in unsupervised learning is:
  - **Clustering**: the model groups similar data elements based on inherent similarities within the dataset.
- *Reinforcement Learning*: in this approach, the model interacts with the environment by performing actions  $a_1, a_2, \dots, a_N$  and receives rewards  $r_1, r_2, \dots, r_N$  in return. The model learns to maximize cumulative rewards over time by adjusting its actions.

**Deep Learning** Deep Learning, a subset of machine learning, focuses on utilizing large datasets and substantial computational power to automatically learn data representations. In certain cases, traditional classification may fail due to the presence of irrelevant or redundant features in the dataset. Deep Learning addresses this issue by learning optimal features directly from the data, which are then used by machine learning algorithms to perform more accurate

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classifications. Essentially, Deep Learning involves learning how to represent data in a way that improves the performance of machine learning models.