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Understanding Machine Learning Concepts

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INTRODUCTION

The intelligence of machines, i.e., their ability to learn in a way similar to how humans do, is increasingly important in many domains. Within the so-called Artificial Intelligence (AI), Machine Learning (ML) stands out, which is the branch of Artificial Intelligence that allows machines to learn without being expressly programmed for it.

Machine Learning is present in many ways in our daily lives, even though we are not aware of it. The recommendations of popular applications such as Netflix or Spotify, or Alexa speech are just some quick examples that Machine Learning is already fully present in our society, and not only in the field of engineering and technology, but in the everyday life of the ordinary citizen.

In this chapter, the authors want to explain what Machine Learning is, as well as to clearly establish the differences and relation of Machine Learning with other important related concepts such as Artificial Intelligence or Deep Learning. Moreover, some possible practical use cases and applications will be named in order to give the reader a clear idea of what the potential of Machine Learning is.

To fulfil this objective the rest of the chapter is organized in several sections that provide brief and clear descriptions of the main concepts regarding 1) Artificial Intelligence, 2) Machine Learning (covering Supervised, Unsupervised, Semisupervised and Reinforcement Learning) and 3) Deep Learning. Finally, future research directions are suggested, and the main conclusions are presented.

BACKGROUND

Defining Artificial Intelligence is not a simple task (Wang, 2019). Artificial Intelligence can be seen as the intelligence exhibited by machines, that is, the study of the intelligent agents of any device that are capable of perceiving their environment and taking actions that allow a certain objective to be successfully carried out. Therefore, it is possible to speak of Artificial Intelligence if a machine imitates the cognitive functions of the human being to learn and solve problems. Artificial Intelligence has undergone great development in recent years. Today, there are many areas where it is being used successfully. Some examples are speech recognition, high-level competition in strategy games such as chess, autonomous vehicles, smart roads, smart buildings, intelligent routing in energy distribution networks, etc.

A good part of the success of Artificial Intelligence is due to the limited human ability to face certain types of problems, which solution would require to invest an enormous amount of time and resources, and also without guarantees of success. An example is the limited human ability to find relevant patterns, objects, or variables within a large mass of data. The problem becomes more complex and beyond the reach of human capabilities as the amount of data to be examined increases. Also, patterns, objects, or variables may sometimes not be easy for the human eye to detect. However, machines can learn to distinguish the patterns and make a reasonably good prediction (Ongsulee, 2017).

In order for the massive data analysis to be effective, computers that offer significant computational capacity, which is not diminished with the passage of time and / or exhaustion, should be used. Moreover, for the analysis of the data to be effective, a specific process is required, so that the computer executes a series of sentences in a precise order to achieve the objective set.

For an Artificial Intelligence system to be able to take decisions based on the data available, different type of learning methods, such as Machine Learning need to be applied.

MACHINE LEARNING

Machine Learning is a learning technique that gives machines the ability to learn without being explicitly programmed. It addresses the study and creation of algorithms that are capable of learning from data and making predictions about it. It is also important to notice that Machine Learning is seen as a subset of Artificial Intelligence, and not the other way around.

According to Raz, Llinas, Mittu and Lawless (2020), the basic idea behind Machine Learning methods is that a computer algorithm is trained to learn the behavior presented as part of previous experience and/ or dataset to the extent that an outcome can be produced by the computer algorithm when it is presented with a never-before-seen dataset or situation.

Cohen (2021) explains that Machine Learning refers to a class of computer algorithms that learn from examples rather than being explicitly programmed to perform a task. It learns to formulate a general rule from a set of concrete examples. Thus, like human learning, the computer becomes capable of improving its performance from acquired knowledge. The difference is that, at the current state of our knowledge, the computer needs many more learning examples than humans do.

One of the main driving factors of the Machine Learning hype is related to the fact that it offers a unified framework for introducing intelligent decision-making into many domains (Bonetto & Latzko, 2020). This type of learning is used in many areas where good performance is necessary, and where the development of algorithms to achieve the desired objectives would be complex.

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