

BDMA - Machine Learning

Jose Antonio Lorenzo Abril

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Professor: Tom Dupuis

Student e-mail: jose-antonio.lorenco-abril@student-cs.fr

This is a summary of the course *Machine Learning* taught at the Université Paris Saclay - CentraleSupélec by Professor Tom Dupuis in the academic year 23/24. Most of the content of this document is adapted from the course notes by Dupuis, [1], so I won't be citing it all the time. Other references will be provided when used.

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Part I

Deep Learning

1 Introduction

Artificial Intelligence is a wide concept, encompassing different aspects and fields. We can understand the term AI as the multidisciplinary field of study that aims at recreating human intelligence using artificial means. This is a bit abstract, and, in fact, there is no single definition for what this means. Intelligence is not fully understood, and thus it is hard to assess whether an artificial invention has achieved intelligence, further than intuitively thinking so.

For instance, AI involves a whole variety of fields:

- Perception
- Knowledge
- Cognitive System
- Planning
- Robotics
- Machine Learning (Neural Networks)
- Natural Language Processing

Leveraging all of these, people try to recreate or even surpass human performance in different tasks. For example, a computer program that can play chess better than any human could ever possibly play, such as Stockfish, or a system that is able to understand our messages and reply, based on the knowledge that it has learnt in the past, such as ChatGPT and similar tools. Other examples are self-driving cars, auto-controlled robots, etc.

Therefore, AI is a very wide term, which merges many different scientific fields. **Machine Learning**, on the other side, is a narrower term, which deals with the study of the techniques that we can use to make a computer learn to perform some task. It takes concepts from Statistics, Optimization Theory, Computer Science, Algorithms, etc. A relevant subclass of Machine Learning, which has come to be one of the most prominent fields of research in the recent years, is **Neural Networks** or **Deep Learning**, which consists on an ML technique based on the human brain. Many amazing use cases that we see everywhere, like Siri (Apple assistant), Cortana (Windows assistant), Amazon recommender system, Dall-E (OpenAI image generation system), etc. Not only this, but the trend is growing, and the interest in DL is continuously increasing.

This is partly also due to the increase in computing resources, and the continuous optimization that different techniques are constantly experiencing. For instance, for a model trained on one trillion data points, in 2021 the training process required around 16500x less compute than a model trained in 2012.

But not everything is sweet and roses when using DL. Since these systems are being involved in decision making processes, there are some questions that arise, like whose responsibility is it when a model fails? Moreover, data is needed to train the models, so it is relevant to address how datasets should be collected, and to respect the privacy of the people that produce data. In addition, the recent technologies that are able to generate new content and to modify real content, make it a new issue that AI can create false information, mistrust, and even violence or paranoia.

Nonetheless, let's not focus on the negative, there are lots of nice applications of DL, and it is a key component to deal with data, achieving higher performance than traditional ML techniques for huge amount of data.

1.1 AI History

In 1950, Alan Turing aimed to answer the question '*Can machines think?*' through a test, which came to be named the **Turing Test**, and consists in a 3 players game. First, a similar game is the following: 2 talkers, a man and a female, and 1 interrogator. The interrogator asks questions to the talkers, with the aim of determining who is the man and who is the female. The man tries to trick the interrogator, while the woman tries to help him.

Then, the Turing Test consists in replacing the man by an artificial machine. Turing thought that a machine that could trick a human interrogator, should be considered intelligent.

Later, in 1956, in the Dartmouth Workshop organized by IBM, the term **Artificial Intelligence** was first used to describe *every aspect of learning or any other feature of intelligence can be so precisely described that a machine can be made to simulate it.*

2 Machine Learning Basics

3 Deep Neural Networks

Part II

Reinforcement Learning

References

- [1] Tom Dupuis. Machine learning. Lecture Notes.