

Foreword

In 1953, Isaac Asimov published *Second Foundation*, the third book of the *Foundation* series (or the thirteenth according to other sources, this is a subject of debate). In *Second Foundation* Arkady Darell, one of the main characters of the final part of the saga, appears for the first time. In his first scene, Arkady, who is 14 years old, is doing his homework. Specifically, an essay entitled "Seldon Plan". To do the writing, Arkady is using a "transcription machine", a device that converts his voice into written words. Arkady speaks into the machine and it prints out his words in a fancy calligraphic font. This type of device, which for Isaac Asimov was science fiction in 1953, is available in most of our smartphones, and Deep Learning is one of the factors responsible for it, in addition to advances in technology.

On the other hand, the computing technology currently available is another of the key factors responsible for us having these applications. Nowadays we have GPUs (Graphics Processor Units), which only cost around 100 euros, which would be on the Top500 list a few years ago (competing with machines that cost millions of euros). The GPUs were designed to facilitate the programming of video games, but a combination of small changes (unified shaders, shared memory, memory access instructions, Tensor Cores ... it may not be so small!), and the emergence of new programming models (CUDA, OpenCL, OpenACC), have facilitated the efficient use of GPUs in general-purpose applications, including Deep Learning. In addition, considering that every year more than 1,000 million smartphones are sold (all of them have a GPU) and that the videogame business is very attractive, it is guaranteed that the technological improvement of GPUs will continue for a long time.

I have known Jordi for more than 30 years; He has always been very concerned about the latest technological advances, not only in our area of knowledge, *Computer Architecture*, but also in broader issues that we could include in what is known as *Computer Science*. Jordi is thinking about research, but also about transferring that knowledge to our students (this, and no other, is the ultimate goal of research at the university). Considering this, it is not surprising that he has embarked on publishing a series of books dedicated to Deep Learning. These tools are changing the way computer problems are addressed and are opening the spectrum of what a computer can do.

And what will the future hold? To be better informed, we can start reading this book, but in the next few years, we will have a series of revolutionary applications closely related to Deep Learning: autonomous cars, natural language processing, machine translation...

Those who will have many more difficulties will be the writers of science fiction: It will be very difficult for them to imagine new devices that have not already been designed by current engineers.

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