Introduction

This is the second edition of my book “Applied Deep Learning” that has been updated for TensorFlow 2.X. The goal of this book is to teach you the necessary fundamentals of how neural networks works, how to train them and how to implement them with Keras. We will start from what is a neuron, what you can achieve with just one, then move to multiple layers in feed forward neural networks. You will learn what is regularization and how to use it, how advanced optimizers (as Adam) works and how to do hyperparameter tuning. At the end we will look at some advanced topics, as autoencoders, metric analysis and generative adversarial networks (GANs). If you are new to the subject, I suggest you read the chapters in order, but if you have already some experience, and you want to look at a specific topic, you can directly jump to the relevant part. The chapters are self-contained, but each refers to concepts explained in previous ones so in case you don’t know what a specific symbol or concept means, you can refer to the previous chapters. I worked hard to keep the mathematical notation and programming style as consistent as possible to make following the book easier. In the book I only discuss very short code snippets (the one I consider relevant) so you will not find complete code to copy and use, but don’t worry. This book has an online version where you will find lots of Jupyter notebooks that you can use and that will be updated regularly with new examples and topics. You can find them at

<https://adl.toelt.ai>

So anytime you would like to see complete code in action, go there and you will find complete examples that you can download or open in Google Colab to try the examples yourself. TensorFlow gets updated very often and giving in the book lots of code examples would make the book age very quickly! My suggestion is to study the concepts here in the book, and then go to the online version to try the complete code to see how what you learned works in practice.

At the end of each chapter there are some exercises that have the goal of making you think about what you learn and give you interesting insights.

# Whom this book is for

To profit from this book you should have an intermediate python programming experience. It is good if you understand how the NumPy library works, since it is used extensively with TensorFlow and therefore learning it pays off. You should also have a basic understanding of algebra and calculus. You should understand *at least* the following concepts:

* What is a matrix
* How to do basic operations on matrices, like multiplication, inverting them, etc.
* What a derivative is (and what a partial derivative is)
* How to calculate easy derivatives
* Know what a function is and what it means to minimize it

If you understand those concepts, you should be fine in following the explanations in the book. I marked the sections that are more mathematical heavy, and if you want you can skip them without too many consequences. I also always give many practical hints in the book to make clear what the implications of the theoretical concepts are in practice. I hope they will help you in your real-life projects.

# Do I need to know TensorFlow/Keras?

This is a tricky question. The more you know the more you will be able to profit from the book. But the main goal of this book is not to teach you Keras, but to teach you how neural networks work and give you implementation examples in Keras. Let me stress it again: the focus is on “understanding how neural networks work”, not on how Keras works. This is **not** a book on Keras. The best way of learning all the particularities of Keras is to look at the official documentation (https://www.tensorflow.org/learn) that is always up-to-date and contain many examples. This book will cover the necessary skills you will need to understand basic examples but if you want to really understand all subtleties, you should go to the official documentation and study it.

**Note** You will probably be able to understand most of the concepts even without knowing how Keras work, but the more experience you have, the easier it will be for you to follow the explanations.

# Which version of TensorFlow is used in this book

The code developed in this book has been tested on TensorFlow 2.5. I try to use only the very fundamental Keras features to make it as compatible as possible with older and future version, but if you are using a different TensorFlow version you may find that some code will not work. If you are running the code from <https://adl.toelt.ai> locally and you encounter this problem I suggest you create a virtual environment[[1]](#footnote-1) with TensorFlow 2.5. Versions of other packages as numpy or pandas should not matter much and any relatively modern (let’s say from 2020 or 2021) version should work just fine.

# How to try the code in the book

There are several ways of trying the code we will discuss in this book. I have worked very hard to make sure that you can run all the examples in the book in Google Colab (<https://colab.research.google.com/>), so that you don’t have to install anything on your personal laptop or PC. If you go to <https://adl.toelt.ai> you can open all the examples directly in Google Colab. If you are on a page at <https://adl.toelt.ai> simply over the mouse over the small rocket icon on the top right of the examples (see Figure 1). You can see that you will have several options to open the notebook in an environment to try it.

Graphical user interface, application

Description automatically generated

Figure 1: by overing with the mouse over the small rocket icon on the top right of the pages at <https://adl.toelt.ai> you can open the notebook directly in Google Colab without the need of install anything on your laptop or machines.

You can simply choose Google Colab, then the notebook will be opened in a browsed directly in Google Colab so that you can test the code directly. Additionally, by clicking on the icon with the arrow pointing down on the right of Figure 1, you can also directly download it on your laptop and run it locally in case you prefer[[2]](#footnote-2).

**Note** You will be able to run all the examples discussed in the books in Google Colab. You will find a direct link to open the notebooks online by going to <https://adl.toelt.ai> and by overing with the mouse over the small rocket icon on the top right of the page.

In case you don’t know how Google Colab works, I suggest you watch the very short introductory video at <https://www.youtube.com/watch?v=inN8seMm7UI>. Basically, Google Colab is an online Jupyter notebook with the Python engine running on Google servers. If you have worked with Jupyter notebooks before you should be fine. If not, I suggest you go to the official project page <https://jupyter.org> and study the many available tutorials. The Jupyter notebook environment is widely used to do data science and is something that every practitioner should know.

# Final Words

I hope that this book will give students a clear curriculum to follow to study neural networks in the most structured and easy way. The topics are not easy and require effort and time. Thus, the students should not be discouraged. Unfortunately to do real machine learning projects is very different than simply copying-pasting from blogs in internet. Programming is only a part of it, and without knowing how the algorithms work, writing code will be useless, and in the worst case will give wrong results.

I hope that readers will find this book useful and that they will profit from it for their careers and research projects.

Dübendorf, 29th October 2021

1. You can find instructions on how to do it on the official Python webpage at <https://docs.python.org/3/tutorial/venv.html>. If you are using Anaconda you can find a large amount of information on their official documentation at <https://bit.ly/3kjQDeL>. [↑](#footnote-ref-1)
2. This will of course require a local python installation with the necessary packages installed. [↑](#footnote-ref-2)