# Deep Learning with PyTorch: CIFAR10 object classification

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January 24, 2020

## 1 Introduction

In this practical course we will study different structures of deep convolutional neural networks to work on image classification using the *PyTorch*[1] Python library. The course (theory) material can be downloaded from: `http://perso.ensta-paristech.fr/~filliat/Courses/index.html` and `http://perso.ensta-paristech.fr/~manzaner/Cours/ROB313/`. Due to the time constraints of the course, we will work with a smaller network that is partially representative of real applications in order to test the capacity of deep learning techniques. The main objective is to understand the structure of convolutional networks and the influence of their parameters over the learning process.

## 2 Running the notebook

**Requirements**: Please get a Gmail account if you do not have one, and make sure you have free space in your Google Drive. To run the PyTorch tutorial colab notebook, only a browser is needed (no installation!), the instructions are valid for the upcoming PyTorch 1.0 version and Google provides free servers with GPUs (which results on a 37x boost in the tutorial on a matrix multiplication). Before start working on it, you should make a copy into your Google Drive of the following colab notebook: `https://colab.research.google.com/drive/1B5KQvPySqYEa6XicRHdOwgv8fN1BrCgQ` (*File → Save a copy in Google Drive*).

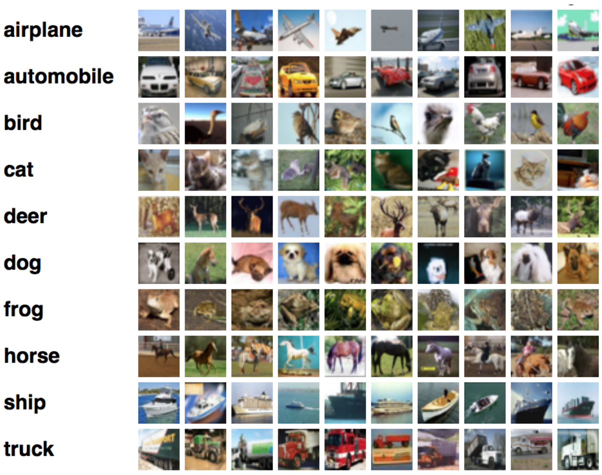

Figure 1: Sample images from CIFAR 10 Database

The notebook will guide you through the use of the CIFAR10 database (Figure 1) with ten categories of objects and the construction of an artificial neural network to classify them. Each image is 32x32 pixels and examples of categories are planes, cars, birds, etc. (The data can be downloaded automatically by

[1] `http://pytorch.org/tutorials/index.html`

the notebook). Extra support slides on convolutional network operators are in https://tinyurl.com/ybxrjtc5.

## 3 Reporting

Send ONLY a link to the exported version in PDF of your documented colab notebook to:

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latest 3 weeks after the TP. It must contain your commented contribution/experiments, detailing what you have done in part III: explain what neural networks and hyper parameters configurations you tested, the resulting performances and trade-offs found. The colab-report should be the same file. You can also give the link to your github repo (in the colab notebook do: *File → Save a copy in Github*, and add that link to your repo in your report).

Provide an interpretation on the losses plot for your top performing configurations and insights on potential improvements. What is happening when the training and test losses start diverging? All used parameters must be reported (at least learning rates, batch size, nr of epochs, accuracy on the image test set and plot of losses). The best performance will be used for a ranked leader board. You can try to modify:

- The neural network structure (kernel size, number of feature maps, number of convolutional layers, size of fully connected layers, ...
- The size of the training set/validation set
- Batch size, number of epochs, learning rates

## 4 Q &A

- Notebook tested on Chrome/Firefox on Ubuntu (16.14)/Open SUSE. If you get (Chrome on Mac): *TypeError: Failed to fetch at ....* 1. Try using a private browser window (or equivalently, cleaning cookies); for Chrome, it worked. It is normally intermittent. 2. Try a different browser, and study in the mean time https://drive.google.com/file/d/1_Kbs4c7yyOgMvsaQzZ3x-EptDp0eDHaK/view?usp=sharing to see full output of the notebook. You can run locally a notebook copying the commands on the outdated PyTorch version installed in the ENSTA lab classroom 1.2.13 virtual machine that is activated by running 'torchvision' in the terminal. 3. You can also run the very close official Pytorch tutorial https://pytorch.org/tutorials/beginner/blitz/cifar10_tutorial.html#sphx-glr-beginner-blitz-cifar10-tutorial-py.
- *Runtime disconnected*: you did not do anything during quite a long time (just reload the notebook/reconnect). Try cleaning your browser cookies + running in private window on Chrome
- If you get *Permission error*,Tip: try file *rightarrow Copy notebook* instead of *Opening in playground mode*.

## Acknowledgements

This short practical is strongly based on the courses:

- Coursera DeepLearning.ai by Andrew Ng
  https://www.coursera.org/learn/convolutional-neural-networks

More complete tutorials and courses can be found at:

- Python Numpy http://cs231n.github.io/python-numpy-tutorial/ and IPython tutorials http://cs231n.github.io/ipython-tutorial/

- Andrej Karpathy course CS231n Convolutional Neural Networks for Visual Recognition http://cs231n.github.io/
- MILA tutorials: https://github.com/mila-udem/welcome_tutorials/tree/master/pytorch
- PyTorch's excellent tutorials: http://pytorch.org/tutorials/beginner/blitz/cifar10_tutorial.html
- Applications with PyTorch: https://twitter.com/pytorch
- Learn PyTorch with no Deep Learning background with Sung Kim's PyTorchZeroToAll https://github.com/hunkim/PyTorchZeroToAll
- A guide to convolution arithmetic for deep learning, Vincent Dumoulin and Francesco Visin: https://github.com/vdumoulin/conv_arithmetic.
- Deep Learning. I. Goodfellow, Y. Bengio and A. Courville, MIT Press, http://www.deeplearningbook.org, 2016.
- Deep Learning with Python, Francois Chollet, Manning Publications. 2017, https://github.com/fchollet/deep-learning-with-python-notebooks
- AI Gitbook: https://leonardoaraujosantos.gitbooks.io/artificial-inteligence/content/making_faster.html