

HT2020: IL2230 HADL Lab 2

Convolutional Neural Networks for Image Classification in PyTorch

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1 Introduction

The deep learning framework we use in IL2230 is PyTorch, which is free and open-source software released under the Modified BSD license. It is primarily developed by Facebook's artificial intelligence research group.

PyTorch is a Python based library built to provide flexibility as a deep learning development platform. The workflow of PyTorch is as close as you can get to python's scientific computing library – numpy.

If you lack knowledge on Python, please go through an excellent online tutorial: The Python Tutorial <https://docs.python.org/3/tutorial/> Python is an interpretive powerful programming language which is easy to learn and convenient to use. It has high-level data structures with object-oriented programming. It is excellent for scripting and rapid application development.

2 Purpose

The laboration is for the beginners of PyTorch users and deep learning learners. It has the following objectives:

- Get familiar with a deep learning framework
- Study neural network training and inference with examples

Specific goals to be achieved:

- Understand PyTorch's Tensor library and neural networks at a high level.
- Train a small neural network to classify images
- Get the first-hand experience on the complexity of CNN design

3 Tasks

PyTorch is well documented. Its official website provides a rich source of very good tutorials. Your task is to learn from scratch, starting from installation to use. This is a group work with two students per group. Each group submits one short technical report.

3.1 Installation

For installation, use the package manager Anaconda, which installs all dependencies.

<https://www.anaconda.com/distribution/>

1. Download and install Anaconda (Python will be installed as part of the installation)
2. Open a command window with Anaconda
3. Run the following command to install pytorch

```
conda install pytorch torchvision -c pytorch
```

Optionally, you can create a virtual environment for pytorch. You may refer to “Create virtual environments for python with conda”.

<https://uoa-ereseach.github.io/ereseach-cookbook/recipe/2014/11/20/conda/>

3.2 Tutorial

Follow the tutorial “Deep Learning with PyTorch: A 60 Minute Blitz” to run all the given code.

https://pytorch.org/tutorials/beginner/deep_learning_60min_blitz.html

We run through all the following four parts:

1. What is PyTorch?
2. Autograd: Automatic Differentiation
3. Neural Networks
4. Training a classifier (without the GPU part) (the part with GPU is optional. You can skip.)

To know more about related functions, you may go through another tutorial “Learning PyTorch with Examples”, which introduces Tensors, Autograd, and NN modules.

https://pytorch.org/tutorials/beginner/pytorch_with_examples.html

What is the accuracy of the image classifier? What is the accuracy for each image class?

3.3 Exploration

After the tutorial, you are going to design new CNNs in order to improve the classification accuracy by considering the following adjustments:

1. Increase the number of feature maps. For example, C1 has 6 feature maps. What if you increase it to 8, 10, 12 feature maps? The same goes for C3, with 20, 24, 28 feature maps.
2. Add more convolutional layers, turning the 7-layer neural network into a 9-layer, 11-layer, or 13-layer neural network. You are free to modify the filter size.
3. Experiment with different nonlinear activation functions. Instead of ReLu, try to use sigmoid, tanh.

<https://pytorch.org/docs/stable/nn.html#non-linear-activations-weighted-sum-nonlinearity>

4. Draw accuracy figures with the different setups (number of feature maps, number of convolutional layers, nonlinear activation function) above. Use the original design as the baseline for comparison.

Give your comments on the CNN designs and their accuracy. Which factor has more significant impact on the performance of the classifier? Why?

3.4 Documentation

- Your final task is to write a short technical report mainly about the "3.3 Exploration" tasks you have done.
- In the report, you present your new CNN designs (network structure and per-layer details), and discuss the impact of feature map, layer depth, nonlinear functions on the classification accuracy according to the results you have obtained. Try to use figures and tables to assist your explanations and discussions.

After your lab results have been approved by the lab assistant, submit your report via the Canvas course website:

<https://kth.instructure.com/courses/20640>