

Handed out: 07/11/2019

Due by 11:59 AM EST on Tuesday, 07/16/2019

You are provided with 4 Jupyter notebooks created by Francois Chollet. Please save the unmodified copy of each of those Jupyter notebooks so that you could compare the original results with your own. We are also providing you with PDFs of notebooks with all runs completed.

Before you start running your Jupyter notebooks, please install Python packages: `pillow` and `h5py`.

**Problem 1.** Execute all cells of the notebook `5.1-introduction-to-convnets.ipynb`. Modify cell #7 and capture history object so that you could plot training and validation accuracy. Add a new cell and repeat training with L2 regularization. Use regularization parameter  $l=0.05$  and  $l=0.01$ . Report on effect on overfitting, if any, and accuracy. Do not search for the optimal values for  $l$  and the number of epochs. Just report what you observe. Submit the Jupyter notebook `5.1_yourname.ipynb` as well as the PDF image of that notebook.  
(10%)

**Problem 2.** Examine jupyter notebook `5.2-using-convnets-with-small-datasets.ipynb` Execute all cells including cell 11. Please explain where are the numbers of parameters 896 and 73856 on the summary display for the `conv2d_1` and `conv2d_3` in cell 11 (`model.summary()`) are coming from. Present the actual calculation.  
(15%)

**Problem 3.** Keep on executing cells of the notebook `5.2-using-convnets-...`. The main point of this notebook is a technique called Data Augmentation. You have small dataset but you still want to train your network. One way to do it is to fudge your samples. You transform samples (images in this case) this way and that way and you generate many more images than you originally had. And, surprisingly, the trick works. Pickup an image of cat or a dog and demonstrate that you can generate at least 6 different, modified images of that animal applying independently: `rotation`, `width change`, `high_shift`, `shear`, `zoom` and `horizontal flip`. Execute all cells in the notebook `5.2-using-convnets-...`, including the code you added. Submit a copy of the working notebook and its PDF image.  
(25%)

**Problem 4** Consider Jupyter notebook `5.3-using-a-pretrained-convnet00.ipynb` which demonstrates another two techniques for training networks on small dataset. We will use pre-trained VGG16 network. We are asking you to examine in detail so called Feature Extraction technique. You are welcome to test Fine Tuning which is described towards the end of the notebook. You will need a moderately powerful GPU machine (like Google Colab) to do that. Run all your test on small

numbers of epochs to estimate duration of the training, before you commit to a long run. First run the experiment in cell #9, as provided. Then change that cell and rather than adding just one Flatten and two Dense layers, try adding the trainable portion with one Conv2D, one Flatten and two Dense layers. Capture the history of both training runs and plot loss and accuracy. Submit working notebook (with or without fine tuning portion) and its PDF.

**(25%)**

**Problem 5.** Finally, consider Jupyter notebook `5.4-visualizing-what-convnets-learn00.ipynb`. This notebook demonstrates how you could capture and display values of the activation (feature) maps of different layers in your network, and how you could capture and display images that pass most directly through filters in different layers. Fetch an image of a tiger. Crop the image to the same size as images of cats and dogs used in the notebook. Capture feature maps at different convolutions layers. Select different channels (sub-layers) than the ones displayed in the notebook. Continue experimentation and display for us tensors representing patterns that maximize the activation of several filters in different convolutional layers. Again, experiment with channels (sublayers) different than the ones presented in the notebook. Submit a copy of the working notebook and its PDF image.

**(25%)**

Your notebooks should include all results, images and comments.

Please add your name to every document you submit.

Please provide clear and full comments for all of important steps or changes you are making.