Simon Fraser University
Assignment 2 - CMPT 419/726: Machine Learning, Fall 2018

Date**: October 25th, 2018**

Name: **Anurag Bejju**
Student ID: **301369375**
Professor: **Dr. Greg Mori**

---

5. Fine-Tuning a Pre-Trained Network (30 marks)

Objective: Write a Python function to be used at the end of training that generates HTML output showing each test image and its classification scores. You could produce an HTML table output for example.

Implementation:

Training the model:

A deep neural network is constructed starting from ResNet 50 up to its average pooling layer. Then, a small network with 32 hidden nodes then 10 output nodes (dense connections) is added on top. Then the weights of the ResNet 50 portion with the parameters from training on ImageNet are initialized.

The code performs training on only the new layers using CIFAR10 dataset and all other weights are fixed to their values learned on ImageNet.

Training Parameters:

A sample size of 50000 images spanning over 10 classes are taken to train the model. Also, the entire network was trained for 3 epochs. The 10 classes are as follows:

[plane , car , bird , cat , deer , dog , frog , horse , ship , truck]

Testing the model:

In this part of the code,

#Step 1: I have first created a test set containing 10000 images spanning over 10 classes. This test set was loaded into *testloader* and a batch size of 1 with shuffle enabled is passed here.

#Step 2: Later *the ResNet50_CIFAR()* model is initialized and the saved dictionary values of our training model are loaded onto it.

#Step 3: html_header(): This function get the header part of the html code you want to write the output to.

#Step 4: Then we iterate through each test sample and get the tensor image as well as its corresponding label index.

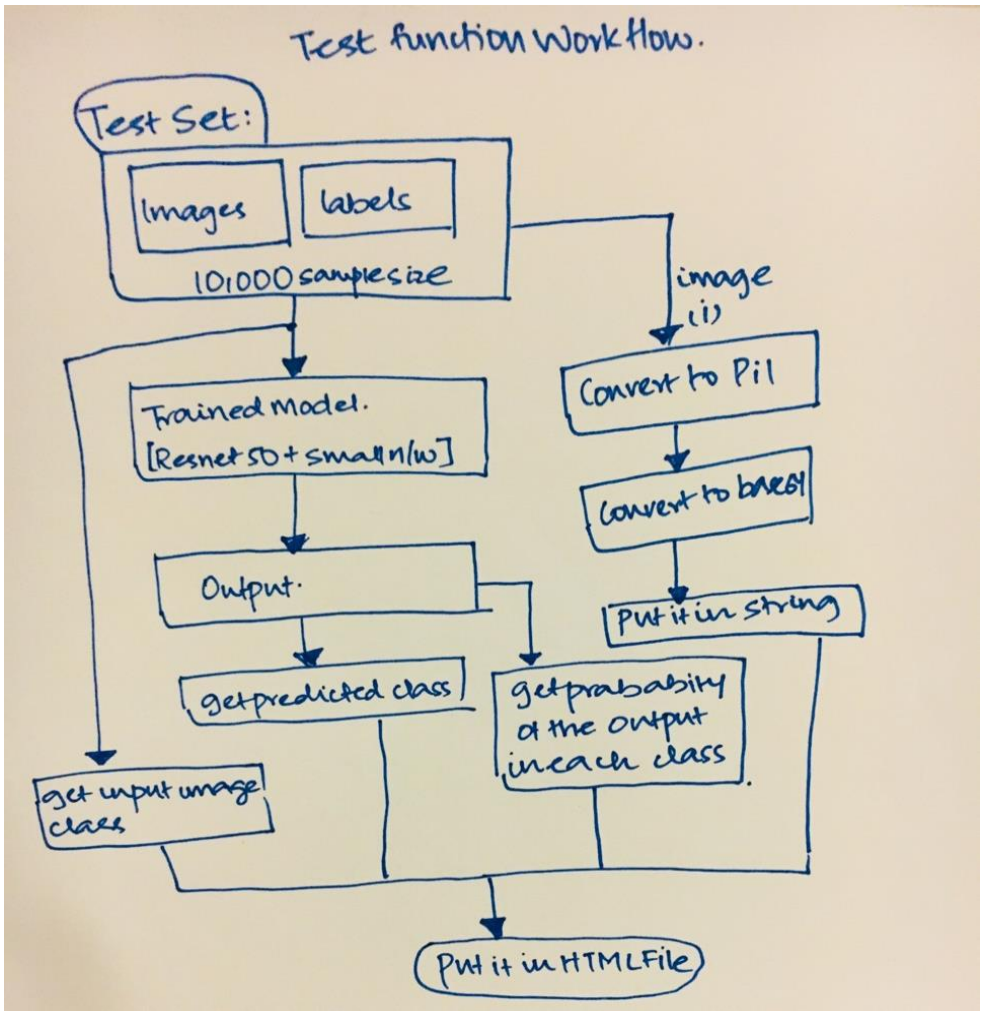


Figure 6: Test Function workflow

#Step 5:

convert_to_pil(inputs):
This function takes in the tensor image and converts it into a PIL image for further processing in the code. Here the input is not cuda enabled as that feature doesn't exists.
def convert_to_pil(inputs): *images_p = inputs / 2 + 0.5* *return(transforms.ToPILImage()(images_p.squeeze()))*

#Step 6:

image_to_base64(image_t):
This function converts image from PIL format to base 64 in order to embed it into a html without saving the image locally.
def image_to_base64(image_t): *in_mem_file = BytesIO()* *image_t.save(in_mem_file, format = "PNG")* *in_mem_file.seek(0)* *img_bytes = in_mem_file.read()* *base64_encoded_result_bytes = base64.b64encode(img_bytes)* *base64_encoded_result_str =* *base64_encoded_result_bytes.decode('ascii')* *return (""+base64_encoded_result_str)*

#Step 7: Then the input values is then passed to the model and predicted class for the output is found

#Step 8:

get_probability(outputs):
This function takes in the outputs and returns the probabilities for the outputs to be classified into any of the 10 classes.
def get_probability(outputs): *sm = nn.Softmax(dim=-1)* *probabilities = sm(outputs)* *return(probabilities.detach().numpy())*

#Step 9: Lastly we put in the Test Image, Test Image class, the predicted class of that image as well as all individual classification scores for that image into a html file.

Libraries Importing: torchvision, torch, numpy, matplotlib, OS, Image (PIL), base64, BytesIO

Steps to run the program:

There are two python files in the directory - *imagenet_finetune.py* [main file] and *a2_p5.py* [file containing functions used in main file].

To run this code, first setup the virtual environment through anaconda.

conda env create -f CONFIG_FILE.

Replace CONFIG FILE with the path to the config files you downloaded. To activate the virtual environment, run the following command

source activate ENV_NAME

Replacing ENV NAME with *cmpt419-pytorch-python36*.
Once the setup is done, make sure that all packages stated in package-list.txt are installed.

Then simply execute*: python3 imagenet_finetune.py*

(Imp: If you want to used a pretrained model and want to turn off the training part of the code, set ***train_new_model = False*** *as well as the* ***model_path*** *with path of the file.)*

Output: A HTML file named **output.html** containing Test Image, Test Image class, the predicted class of that image as well as all individual classification scores. (Next page contains a see a screenshot of it)

Simon Fraser University

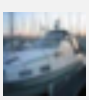
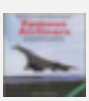
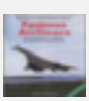
Assignment 2 - CMPT 419/726: Machine Learning, Fall 2018

Name: **Anurag Bejju**
Student ID: 301369375
Date: October 25th, 2018
Professor: Dr. Greg Mori

Question 5: Fine Tuning a Pre-Trained Network:

Test Sample Number	Image	Class	Predicted Class	P(plane)	P(car)	P(bird)	P(cat)	P(deer)	P(dog)	P(frog)	P(horse)	P(ship)	P(truck)
Sample #1		frog	plane	0.340	0.338	0.013	0.046	0.004	0.002	0.182	0.004	0.067	0.004
Sample #2		frog	car	0.014	0.667	0.001	0.003	0.001	0.001	0.171	0.001	0.141	0.001
Sample #3		cat	frog	0.015	0.213	0.011	0.007	0.003	0.009	0.520	0.007	0.205	0.010
Sample #4		cat	frog	0.007	0.036	0.012	0.002	0.002	0.015	0.830	0.005	0.086	0.006
Sample #5		frog	car	0.048	0.434	0.009	0.041	0.004	0.006	0.399	0.006	0.038	0.015
Sample #6		plane	car	0.135	0.689	0.006	0.004	0.007	0.009	0.080	0.002	0.063	0.006
Sample #7		ship	frog	0.012	0.365	0.038	0.012	0.009	0.023	0.444	0.008	0.069	0.020
Sample #8		cat	car	0.044	0.407	0.134	0.081	0.042	0.052	0.154	0.029	0.031	0.025
Sample #9		frog	car	0.079	0.372	0.003	0.068	0.002	0.003	0.325	0.001	0.144	0.004
Sample #10		car	car	0.133	0.292	0.006	0.211	0.004	0.009	0.287	0.002	0.046	0.010
Sample #11		cat	car	0.023	0.713	0.006	0.019	0.004	0.005	0.192	0.004	0.032	0.002
Sample #12		car	car	0.057	0.508	0.003	0.007	0.001	0.003	0.389	0.001	0.027	0.004
Sample #13		plane	car	0.066	0.584	0.020	0.020	0.003	0.004	0.230	0.003	0.064	0.006
Sample #14		ship	car	0.049	0.706	0.028	0.044	0.014	0.019	0.094	0.010	0.014	0.022

Sample #15		cat	frog	0.027	0.387	0.001	0.018	0.000	0.001	0.397	0.001	0.166	0.002
Sample #16		plane	ship	0.147	0.200	0.011	0.104	0.004	0.008	0.191	0.007	0.307	0.021
Sample #17		car	car	0.110	0.385	0.022	0.012	0.008	0.022	0.159	0.007	0.251	0.024
Sample #18		cat	car	0.014	0.392	0.005	0.015	0.001	0.001	0.242	0.003	0.327	0.002
Sample #19		frog	frog	0.103	0.094	0.006	0.018	0.003	0.007	0.601	0.003	0.156	0.009
Sample #20		ship	frog	0.008	0.360	0.005	0.026	0.002	0.009	0.386	0.007	0.186	0.011
Sample #21		cat	car	0.036	0.453	0.011	0.007	0.012	0.030	0.329	0.009	0.085	0.027
Sample #22		cat	car	0.046	0.413	0.024	0.101	0.007	0.003	0.136	0.007	0.253	0.010
Sample #23		frog	car	0.013	0.602	0.002	0.021	0.000	0.001	0.241	0.001	0.118	0.001
Sample #24		frog	car	0.046	0.866	0.014	0.020	0.004	0.002	0.014	0.002	0.022	0.008
Sample #25		ship	car	0.010	0.496	0.004	0.005	0.002	0.010	0.429	0.004	0.037	0.003
Sample #26		frog	frog	0.018	0.084	0.011	0.022	0.001	0.002	0.830	0.001	0.028	0.003
Sample #27		ship	car	0.004	0.641	0.034	0.002	0.007	0.025	0.062	0.007	0.202	0.017
Sample #28		ship	car	0.271	0.422	0.010	0.009	0.007	0.014	0.210	0.003	0.042	0.013
Sample #29		frog	frog	0.010	0.233	0.019	0.045	0.004	0.029	0.512	0.011	0.099	0.039
Sample #30		frog	frog	0.063	0.357	0.001	0.002	0.000	0.001	0.551	0.001	0.025	0.001
Sample #31		car	frog	0.148	0.161	0.008	0.003	0.003	0.008	0.496	0.006	0.156	0.011
Sample #32		cat	car	0.006	0.706	0.008	0.051	0.001	0.001	0.134	0.002	0.085	0.006
Sample #33		car	frog	0.005	0.464	0.002	0.026	0.000	0.001	0.474	0.001	0.024	0.003

Sample #34		ship	car	0.005	0.613	0.004	0.003	0.001	0.004	0.104	0.002	0.262	0.003
Sample #35		frog	frog	0.009	0.340	0.008	0.030	0.003	0.010	0.553	0.007	0.031	0.010
Sample #36		frog	car	0.062	0.562	0.019	0.008	0.004	0.014	0.229	0.006	0.081	0.014
Sample #37		plane	frog	0.117	0.027	0.005	0.138	0.001	0.002	0.672	0.001	0.035	0.004
Sample #38		car	car	0.036	0.784	0.005	0.002	0.003	0.004	0.062	0.008	0.091	0.007
Sample #39		frog	frog	0.040	0.266	0.024	0.020	0.005	0.007	0.490	0.004	0.128	0.016
Sample #40		car	frog	0.005	0.153	0.003	0.028	0.001	0.008	0.769	0.002	0.026	0.005
Sample #41		frog	car	0.026	0.688	0.004	0.024	0.003	0.002	0.188	0.002	0.060	0.002
Sample #42		frog	car	0.004	0.494	0.002	0.000	0.000	0.001	0.469	0.001	0.028	0.001
Sample #43		cat	frog	0.043	0.092	0.014	0.338	0.001	0.002	0.347	0.001	0.157	0.005
Sample #44		car	frog	0.141	0.257	0.005	0.004	0.003	0.007	0.570	0.004	0.005	0.004
Sample #45		ship	car	0.132	0.213	0.127	0.097	0.066	0.097	0.102	0.038	0.059	0.070
Sample #46		car	car	0.014	0.377	0.051	0.110	0.017	0.026	0.258	0.012	0.112	0.021
Sample #47		frog	car	0.048	0.460	0.024	0.028	0.005	0.012	0.298	0.013	0.074	0.039
Sample #48		ship	frog	0.010	0.131	0.019	0.040	0.006	0.012	0.746	0.014	0.010	0.012
Sample #49		plane	car	0.014	0.921	0.002	0.018	0.001	0.000	0.009	0.001	0.033	0.001
Sample #50		plane	car	0.013	0.694	0.029	0.005	0.009	0.022	0.115	0.019	0.059	0.035
Sample #51		ship	car	0.004	0.518	0.002	0.005	0.001	0.008	0.424	0.005	0.030	0.003
Sample #52		car	car	0.011	0.847	0.011	0.011	0.004	0.006	0.087	0.004	0.010	0.008