COMP6721 Applied Artificial Intelligence (Fall 2020)

Project Assignment Part I

Due date : Friday, November 20th

AI Face Mask Detector

Team Name: SS\_G11

Team members:

Lin Li 40044486

Wenhui Guo 40092514

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0. Introduction

In this project, we developed a Deep Learning Convolutional Neural Network (CNN) using PyTorch and train it to recognize three different classes:

(1) Person without a face mask,

(2) Person with a face mask, and

(3) Not a person (i.e., any other image).

In this first phase of the project, we focused on a proper design of our datasets, collecting suitable training data, setting up the complete AI learning & evaluation process and gathering first results. We will further improve it in the second phase of the project.

1. Dataset

***1.1 Create dataset***

In this part we will describe how we built our dataset, the source of collected images and provide details on the dataset.

In order to get better performance for our project, we decided to build our own dataset by collecting images from existing several datasets rather than directly re-use existing datasets. We collected images from public datasets, CelebFaces Attributes Dataset (CelebA); from online community of data scientists and learning practitioners, Kaggle; from personal source code datasets, Git. More details about the source in the Reference Section.

***1.2 Analyse dataset***

Our dataset has two parts, train dataset part and test dataset part. Each part includes three classes.

* Person with a face mask,
* Person without a face mask, and
* Not a person (i.e., any other image).

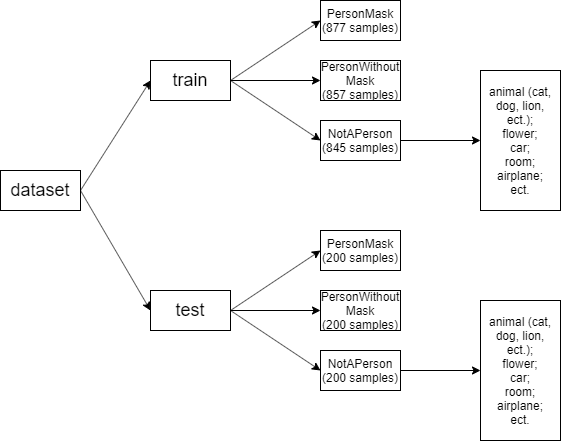


Fig.1 Dataset’s size and structure

这里还大概要写比如person里多少个女人，多少个男人，浅肤色的，深肤色的，孩子

戴口罩里面，多少是很明显的口罩在中间，多少是什么

非人里面，多少是花草树木等等

瞎编就行，不用数，没人在乎

Deliverables:

Dataset: The dataset you collected, as well as a fill detailing the source of each image.

provide details on each image's source in a file

A file detailing the source of each image is provided in “image\_source.txt”.

这个文件要交的，大概瞎编下就行

***1.3 Pre-process datasets***

When we install PyTorch, we also install torchvision library which contains models and transformation operations generally used in the image pre-processing.

To pre-process the data, by using transform method in torchvision, we do resize and center crop when loading each image. The processed dataset is saved to variables “trainset” or “testset”, to be used later.

***1.4 Load datasets***

We use DataLoader in pytorch library to provide API for loading datasets. By creating a DataLoader object, we load the previously created variables “trainset” or “testset” which contain pre-processed images, and feed to our Convolutional Neural Network (CNN) model for training and testing purposes.

Describe how you built your dataset and where you collected images (provide details on each image's source in a file). Provide statistics on the size and structure of your dataset, i.e., how many images you have in each class.

Training Data. Create datasets for training and testing your AI. You have to provide provenance information, i.e., where you obtained each image in your dataset. You can re-use existing datasets, but again please make sure you properly reference the source of the images (name, author, source, license of the dataset). Also, note the additional evaluation task that will follow in Part II of the project mentioned below when setting up your dataset.

2. CNN Architecture

In this part we will describe the architecture of our CNN and provide details on the training.

***2.1 CNN class for Convolutional Neural Network architecture***

In order to create a suitable Convolutional Neural Network (CNN) architecture, implement it in PyTorch, and train it using our dataset, we first create a class inheriting from the nn.Module to define different layers of the network based on provided network architecture above.

We set 2 Convolutional Layers with activation and max pooling, the flatten it to one-dimension vector, then pass it through 3 Full Connection layers, like shown in the teaching material:

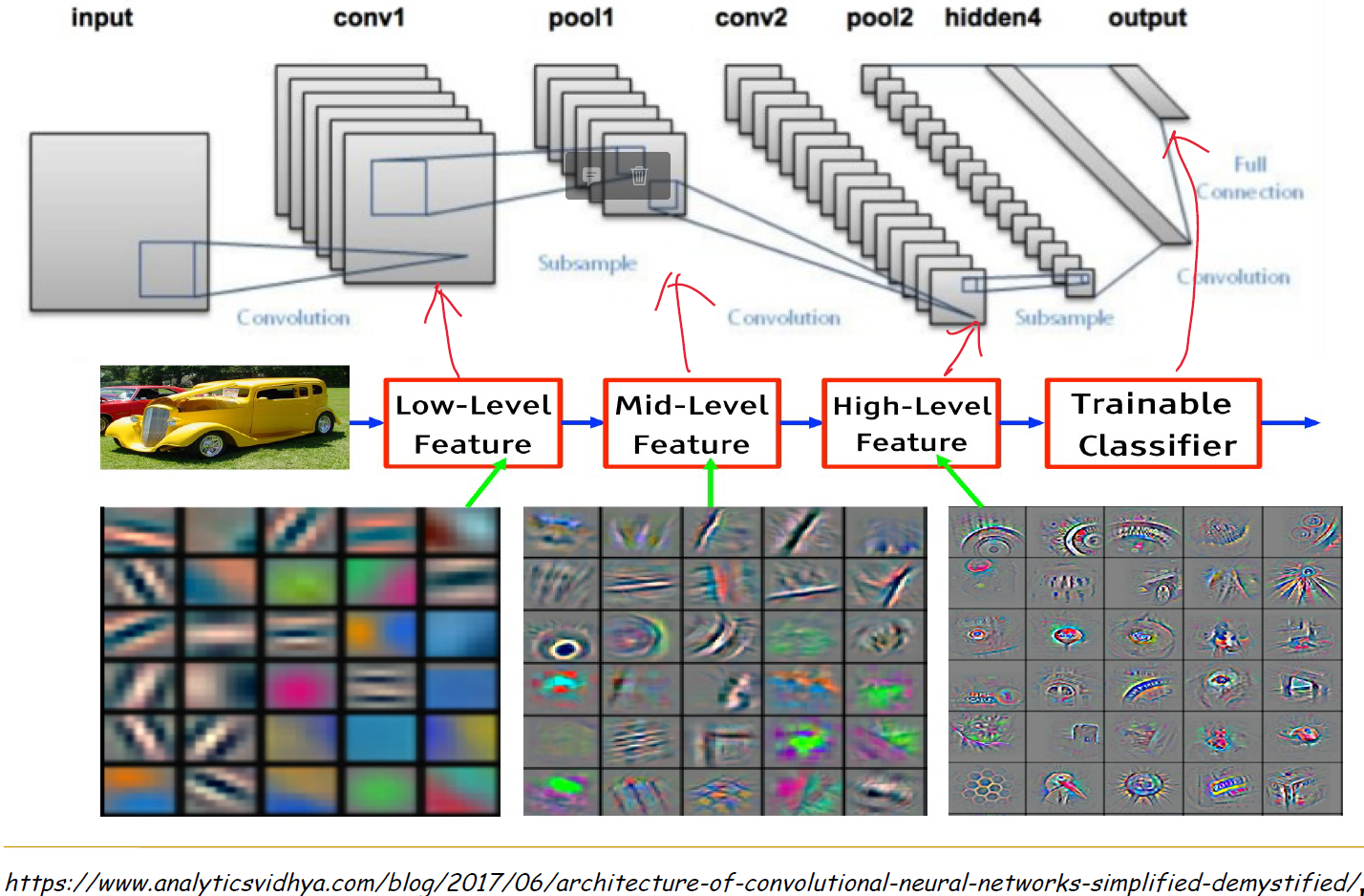


Fig.2 Convolutional Neural Network (CNN) architecture

In our code, we have provided comment for every step, as shown below:

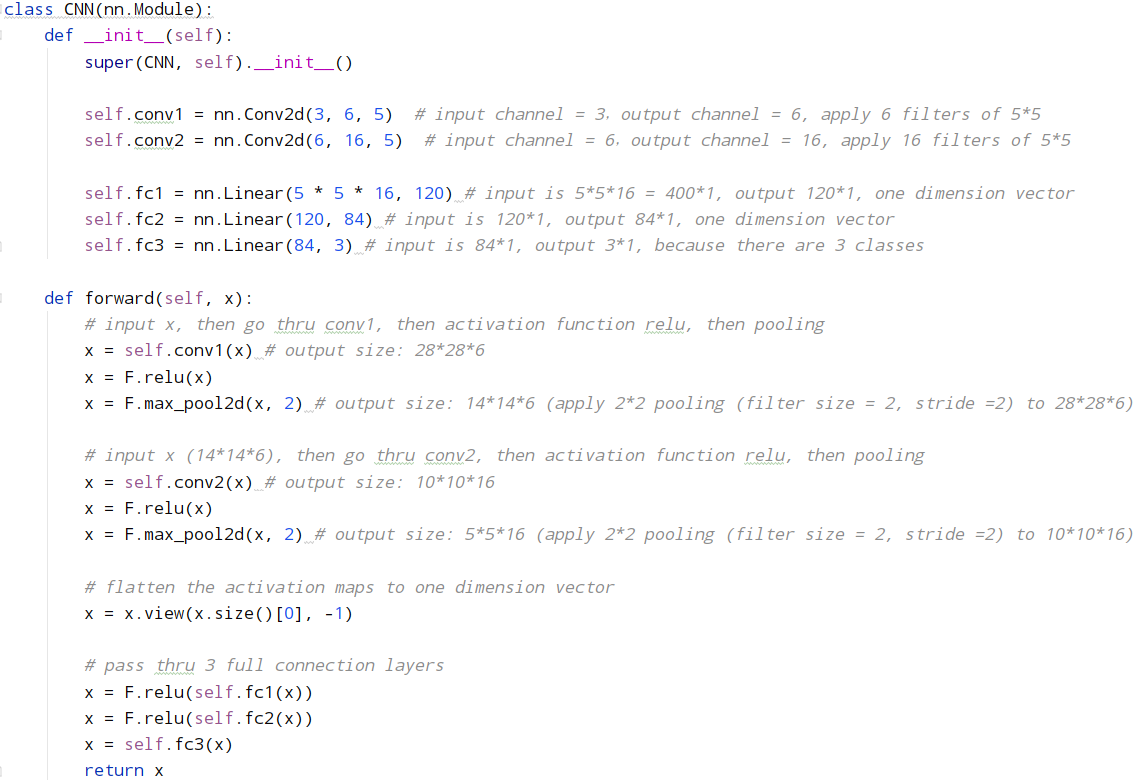


Fig.3 Our Convolutional Neural Network (CNN) setup

***2.2 Train using our CNN model***

In the training phase, we use “train\_loader” to load the images from given path, the images in each sub-folder is labeled with the sub-folder name.

Following what we learned from the lecture and lab, we create an instance of the Convolution class we defined in previous part, then define the optimizer and loss function.

We set the learning rate to be 0.001, this number is small so the weight won’t get changed violently.

We train the model for 10 epochs, for now we can get a final accuracy of 91.17%.

In second phase of the project we can increase this number to achieve better performance.

When training phase is completed, the parameters of our CNN are saved to 2 files:

*net.pkl*

*net\_params.pkl*

This will be read by the testing phase to evaluate our model.

***2.3 Test using our CNN model***

In the testing phase, we use torch.load() method from pytorch library to load the parameters of our CNN which was generated from previous training phase.

Then we use “test\_loader” to load the images from given path, the expected labels are the name of sub-folders, this information will be used to compare with the predicted labels, to evaluate the performance of our CNN model.

3. Evaluation

We provide the data as below to analyze and evaluate our model:

***3.1 Log for training our CNN:***

Average loss and accuracy of each 200 images

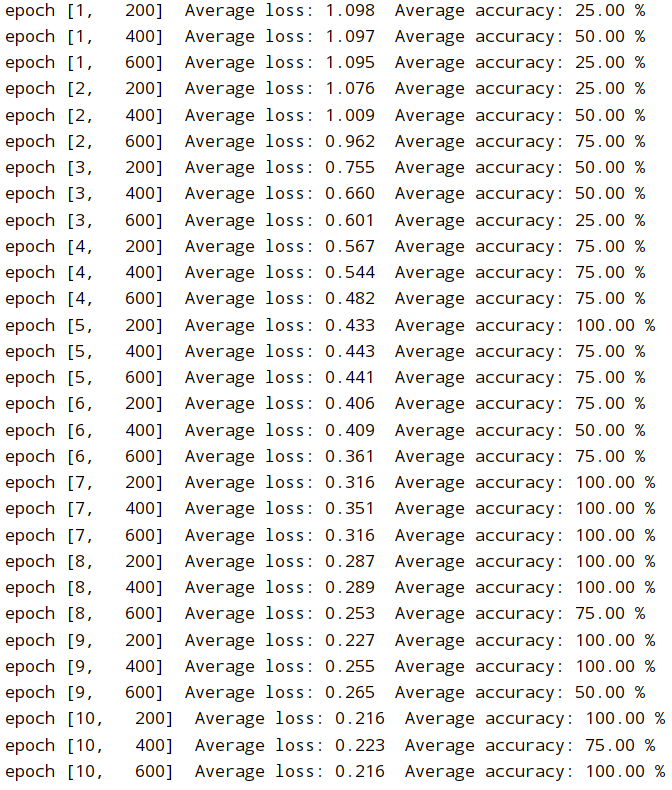


Fig.4 Printed training log

It is obvious that along with the process of training, the average loss decreases, while average accuracy is augmented.

***3.2 A table of results showing the accuracy, precision, recall and F1-measure***

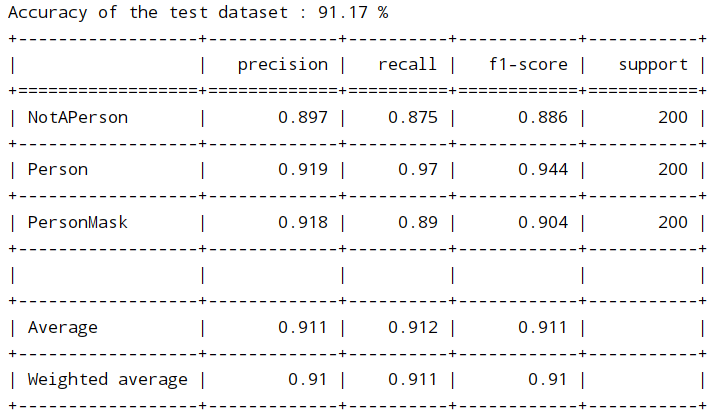


Fig.5 A table of results showing the accuracy, precision, recall and F1-measure

The results of accuracy, precision, recall and F1-measure are acceptable and promising, means we learned the knowledge and skill to build a CNN to do classification.

***3.3 Confusion matrix:***

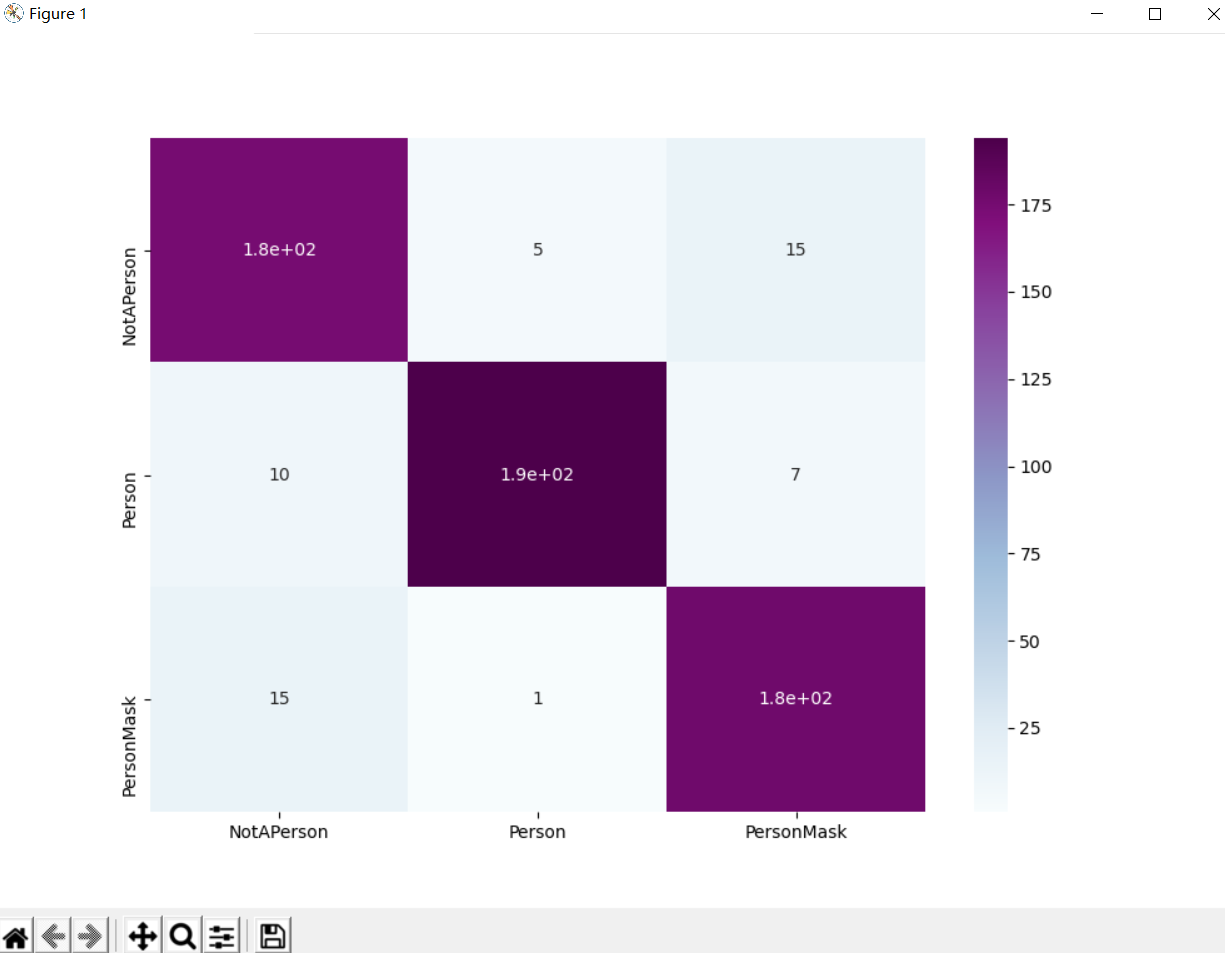


Fig.6 Confusion matrix

As we can see from the Confusion matrix, our CNN model successfully classified majority of the test data.

***3.4 Running time***

Training phase takes: 0:03:02.110196

Testing phase takes: 0:00:41.731781

***3.5 Discuss the results and explain how and where we want to improve during the second phase of the project.***

- We could improve on the structure of our CNN:

* For structure:
* We could increase the number of Convolutional Layers so that the accuracy will be further improved;
* We could add normalization to some steps in Convolutional Layers;
* We could add the step of “dropout random nodes” in Full Connection Layers to avoid certain feature has huge impact on the result;
* For parameters:
* We could change the kernel size of the Convolutional Layers (currently always 5\*5);
* We could add padding (currently no padding);
* We could try other activation functions (currently relu);
* For training phase:
* We could try different loss function (currently using CrossEntropyLoss());
* We could use other optimizer (currently using optim.SGD);
* We could change the learning rate to see if the performance can be further improved (current learning rate = 0.001)
* we could increase the number of images in training set, until it reaches the top of the learning curve (where accuracy hardly could be improved by increasing the size of the training set).
* Also We could increase the number of epochs to minimize the loss, and maximize accuracy, precision, recall and F1-measure.

4. Reference Section

This part contains citations to all relevant resources that we have consulted, even if it was just to inspire us.

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8. LFW-People (Face Recognition), by Atul Anand{Jha}, <https://www.kaggle.com/atulanandjha/lfwpeople>
9. Real-World-Masked-Face-Dataset, by X-zhangyang, <https://github.com/X-zhangyang/Real-World-Masked-Face-Dataset>
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