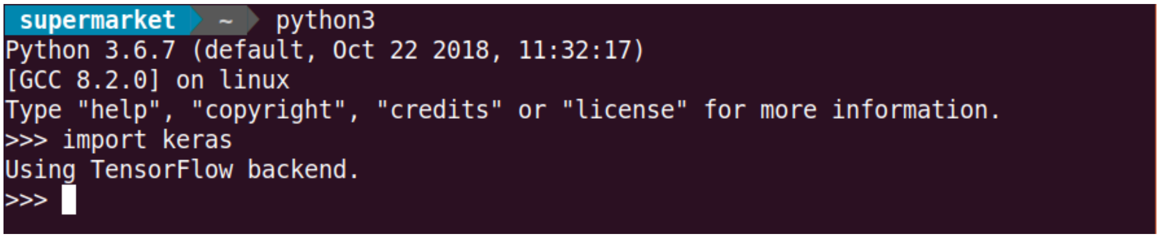
Introduction of Computer

Homework 5 Report

Name: 徐子程
Student ID: B06602037

Your tensorflow version: 1.13.1 (With GPU support , GPU : NVIDIA GTX 1060 6G)
Keras version: 2.2.4
Environment (Windows 10 / MacOS / Linux): Ubuntu 18.04.2 LTS

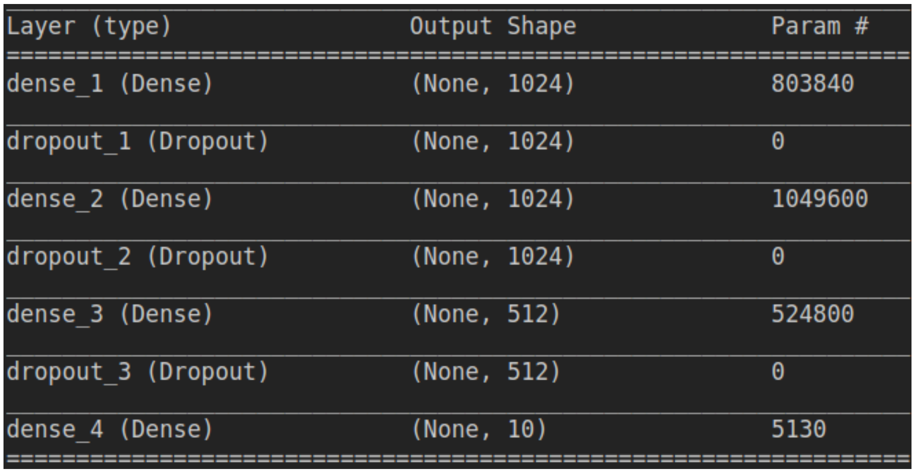
- **Verify Installation (30%)**
  To verify your tensorflow installation, open the python shell and import the package “keras”. There should be a message showing that keras is using the tensorflow backend. Please paste the screenshot here.



```
supermarket  ~  python3
Python 3.6.7 (default, Oct 22 2018, 11:32:17)
[GCC 8.2.0] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> import keras
Using TensorFlow backend.
>>> █
```

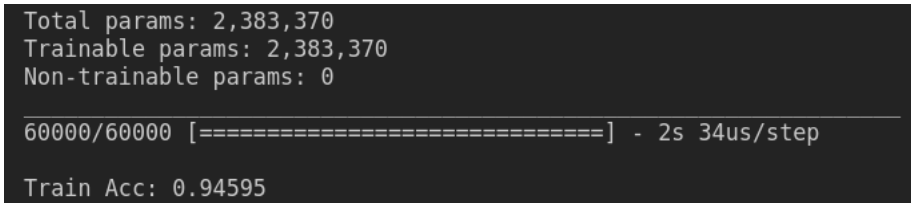
- **Classification with Neural Network**

1. The structure of your best model. (10%)
   3 flatten layers



```
Layer (type)                 Output Shape              Param #
=================================================================
dense_1 (Dense)              (None, 1024)              803840
_________________________________________________________________
dropout_1 (Dropout)          (None, 1024)              0
_________________________________________________________________
dense_2 (Dense)              (None, 1024)              1049600
_________________________________________________________________
dropout_2 (Dropout)          (None, 1024)              0
_________________________________________________________________
dense_3 (Dense)              (None, 512)               524800
_________________________________________________________________
dropout_3 (Dropout)          (None, 512)               0
_________________________________________________________________
dense_4 (Dense)              (None, 10)                5130
=================================================================
```

2. Training accuracy. (5%)
   Up to 0.94



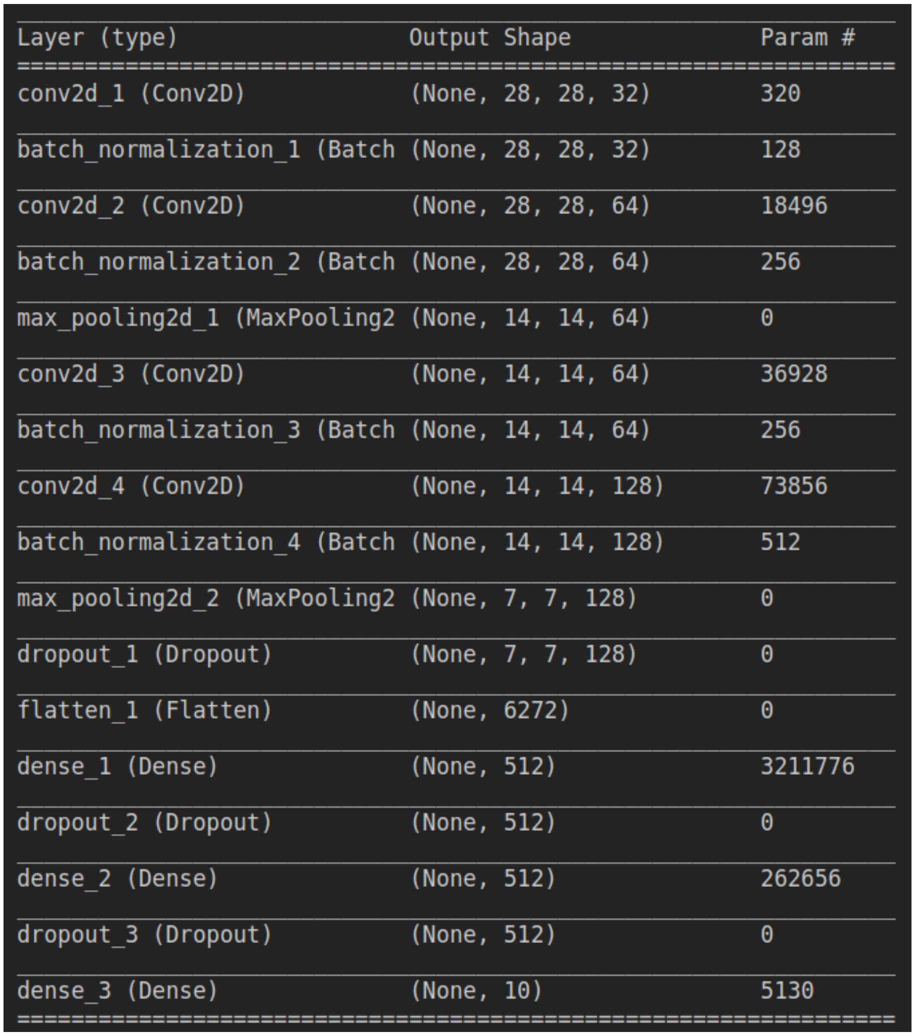
```
Total params: 2,383,370
Trainable params: 2,383,370
Non-trainable params: 0
_________________________________________________________________
60000/60000 [==============================] - 2s 34us/step

Train Acc: 0.94595
```

3. How do you determine the termination of training ? (10%)
   By set the number of training epochs.
   Because we always save the best model (See 4.), we do not need to stop training earlier.

4. How do you determine which model structure is better ? (10%)

   By comparing the validation data accuracy, if the accuracy is better than previous training epoch , we save the model into a file.
   After all training epochs were done, we load the best model for testing data.

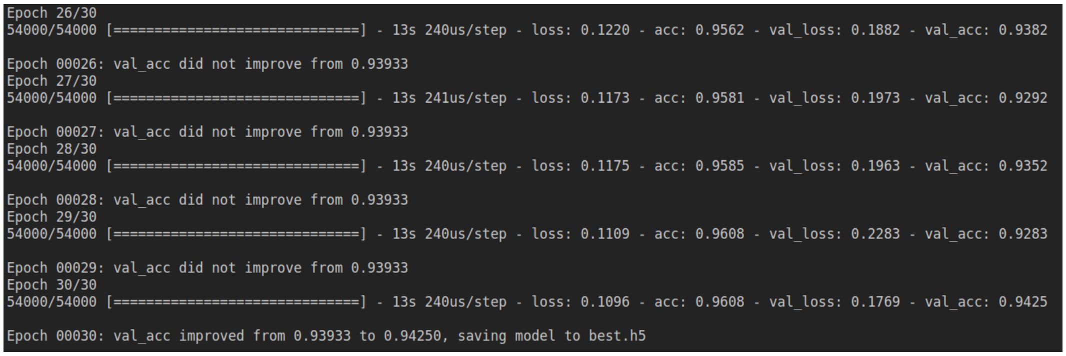
- **Bonus : Convolutional Neural Network**
  Model structure:
  4 convolution layers, 2 pooling layers, 2 flatten layers



```
_________________________________________________________________
Layer (type)                 Output Shape              Param #   
=================================================================
conv2d_1 (Conv2D)            (None, 28, 28, 32)        320       
_________________________________________________________________
batch_normalization_1 (Batch (None, 28, 28, 32)        128       
_________________________________________________________________
conv2d_2 (Conv2D)            (None, 28, 28, 64)        18496     
_________________________________________________________________
batch_normalization_2 (Batch (None, 28, 28, 64)        256       
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 14, 14, 64)        0         
_________________________________________________________________
conv2d_3 (Conv2D)            (None, 14, 14, 64)        36928     
_________________________________________________________________
batch_normalization_3 (Batch (None, 14, 14, 64)        256       
_________________________________________________________________
conv2d_4 (Conv2D)            (None, 14, 14, 128)       73856     
_________________________________________________________________
batch_normalization_4 (Batch (None, 14, 14, 128)       512       
_________________________________________________________________
max_pooling2d_2 (MaxPooling2 (None, 7, 7, 128)         0         
_________________________________________________________________
dropout_1 (Dropout)          (None, 7, 7, 128)         0         
_________________________________________________________________
flatten_1 (Flatten)          (None, 6272)              0         
_________________________________________________________________
dense_1 (Dense)              (None, 512)               3211776   
_________________________________________________________________
dropout_2 (Dropout)          (None, 512)               0         
_________________________________________________________________
dense_2 (Dense)              (None, 512)               262656    
_________________________________________________________________
dropout_3 (Dropout)          (None, 512)               0         
_________________________________________________________________
dense_3 (Dense)              (None, 10)                5130      
=================================================================
```

Observations:
If dropout value is not big enough, overfitting will occur. The better value is around 50%.

Best validation accuracy: Up to 0.94



```
Epoch 26/30
54000/54000 [==============================] - 13s 240us/step - loss: 0.1220 - acc: 0.9562 - val_loss: 0.1882 - val_acc: 0.9382

Epoch 00026: val_acc did not improve from 0.93933
Epoch 27/30
54000/54000 [==============================] - 13s 241us/step - loss: 0.1173 - acc: 0.9581 - val_loss: 0.1973 - val_acc: 0.9292

Epoch 00027: val_acc did not improve from 0.93933
Epoch 28/30
54000/54000 [==============================] - 13s 240us/step - loss: 0.1175 - acc: 0.9585 - val_loss: 0.1963 - val_acc: 0.9352

Epoch 00028: val_acc did not improve from 0.93933
Epoch 29/30
54000/54000 [==============================] - 13s 240us/step - loss: 0.1109 - acc: 0.9608 - val_loss: 0.2283 - val_acc: 0.9283

Epoch 00029: val_acc did not improve from 0.93933
Epoch 30/30
54000/54000 [==============================] - 13s 240us/step - loss: 0.1096 - acc: 0.9608 - val_loss: 0.1769 - val_acc: 0.9425

Epoch 00030: val_acc improved from 0.93933 to 0.94250, saving model to best.h5
```