Lab 4 Deep Learning 1

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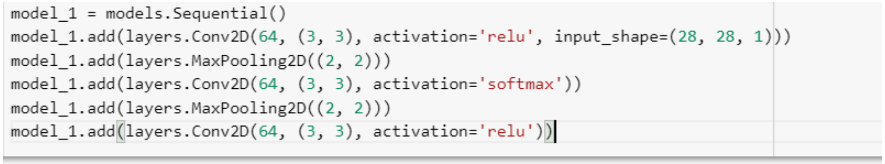
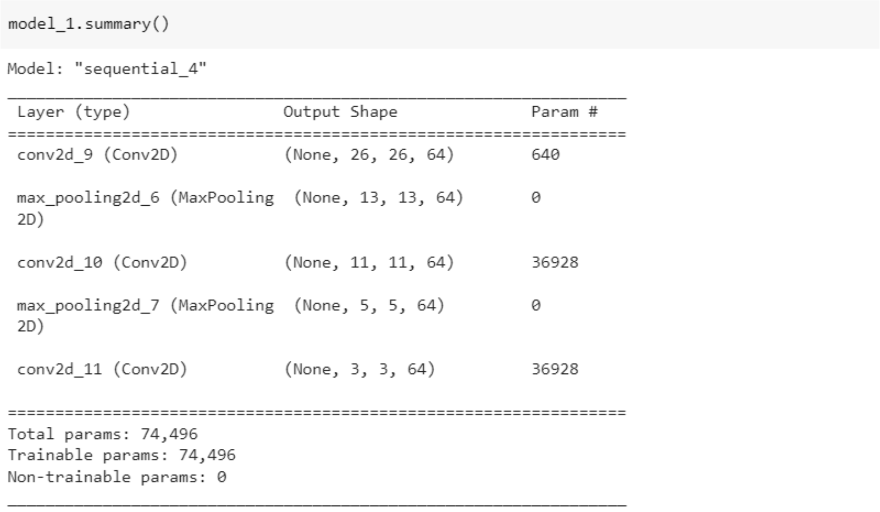
Homework 1

I built a new model and added 3 convolutional leyers, two of them with relu activation function and the other one with softmax activation function. I flattened the layers and add one dense layer (size 64) and relu activation function and one dense layer (size 10) and softmax activation function. Rest of the parameters were unchanged and model was fitted with 10 epochs and with batch size of 58.

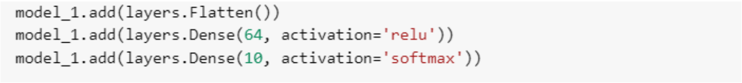


```
model_1 = models.Sequential()
model_1.add(layers.Conv2D(64, (3, 3), activation='relu', input_shape=(28, 28, 1)))
model_1.add(layers.MaxPooling2D((2, 2)))
model_1.add(layers.Conv2D(64, (3, 3), activation='softmax'))
model_1.add(layers.MaxPooling2D((2, 2)))
model_1.add(layers.Conv2D(64, (3, 3), activation='relu'))
```

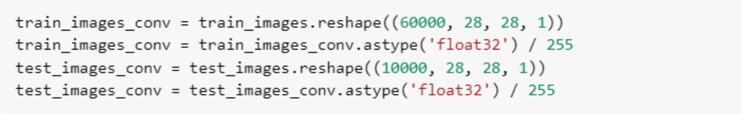


```
model_1.summary()
```

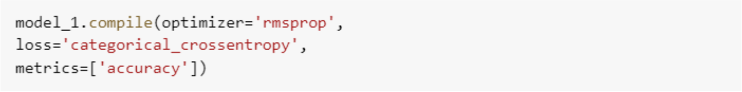
```
Model: "sequential_4"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d_9 (Conv2D)           (None, 26, 26, 64)        640

 max_pooling2d_6 (MaxPooling  (None, 13, 13, 64)       0
 2D)

 conv2d_10 (Conv2D)          (None, 11, 11, 64)        36928

 max_pooling2d_7 (MaxPooling  (None, 5, 5, 64)         0
 2D)

 conv2d_11 (Conv2D)          (None, 3, 3, 64)          36928

=================================================================
Total params: 74,496
Trainable params: 74,496
Non-trainable params: 0
_________________________________________________________________
```



```
model_1.add(layers.Flatten())
model_1.add(layers.Dense(64, activation='relu'))
model_1.add(layers.Dense(10, activation='softmax'))
```

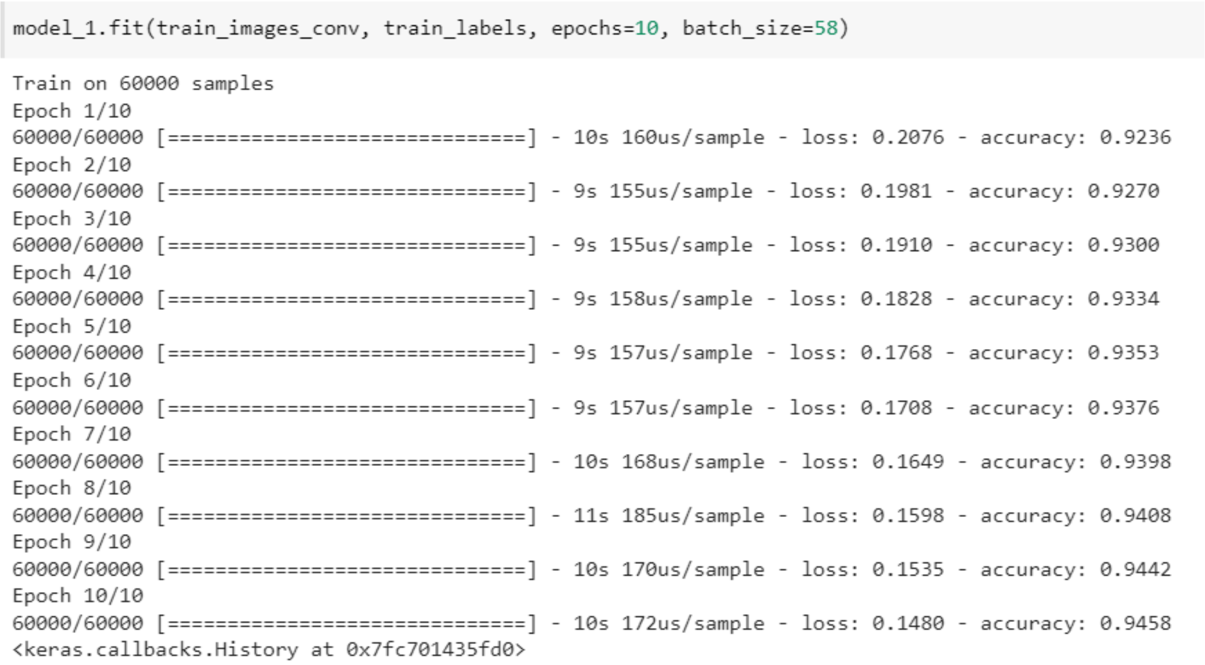


```
train_images_conv = train_images.reshape((60000, 28, 28, 1))
train_images_conv = train_images_conv.astype('float32') / 255
test_images_conv = test_images.reshape((10000, 28, 28, 1))
test_images_conv = test_images_conv.astype('float32') / 255
```



```
model_1.compile(optimizer='rmsprop',
loss='categorical_crossentropy',
metrics=['accuracy'])
```

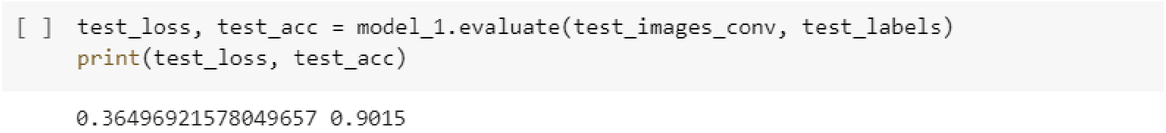
Below I present training accuracy.



```
model_1.fit(train_images_conv, train_labels, epochs=10, batch_size=58)
```

```
Train on 60000 samples
Epoch 1/10
60000/60000 [==============================] - 10s 160us/sample - loss: 0.2076 - accuracy: 0.9236
Epoch 2/10
60000/60000 [==============================] - 9s 155us/sample - loss: 0.1981 - accuracy: 0.9270
Epoch 3/10
60000/60000 [==============================] - 9s 155us/sample - loss: 0.1910 - accuracy: 0.9300
Epoch 4/10
60000/60000 [==============================] - 9s 158us/sample - loss: 0.1828 - accuracy: 0.9334
Epoch 5/10
60000/60000 [==============================] - 9s 157us/sample - loss: 0.1768 - accuracy: 0.9353
Epoch 6/10
60000/60000 [==============================] - 9s 157us/sample - loss: 0.1708 - accuracy: 0.9376
Epoch 7/10
60000/60000 [==============================] - 10s 168us/sample - loss: 0.1649 - accuracy: 0.9398
Epoch 8/10
60000/60000 [==============================] - 11s 185us/sample - loss: 0.1598 - accuracy: 0.9408
Epoch 9/10
60000/60000 [==============================] - 10s 170us/sample - loss: 0.1535 - accuracy: 0.9442
Epoch 10/10
60000/60000 [==============================] - 10s 172us/sample - loss: 0.1480 - accuracy: 0.9458
<keras.callbacks.History at 0x7fc701435fd0>
```

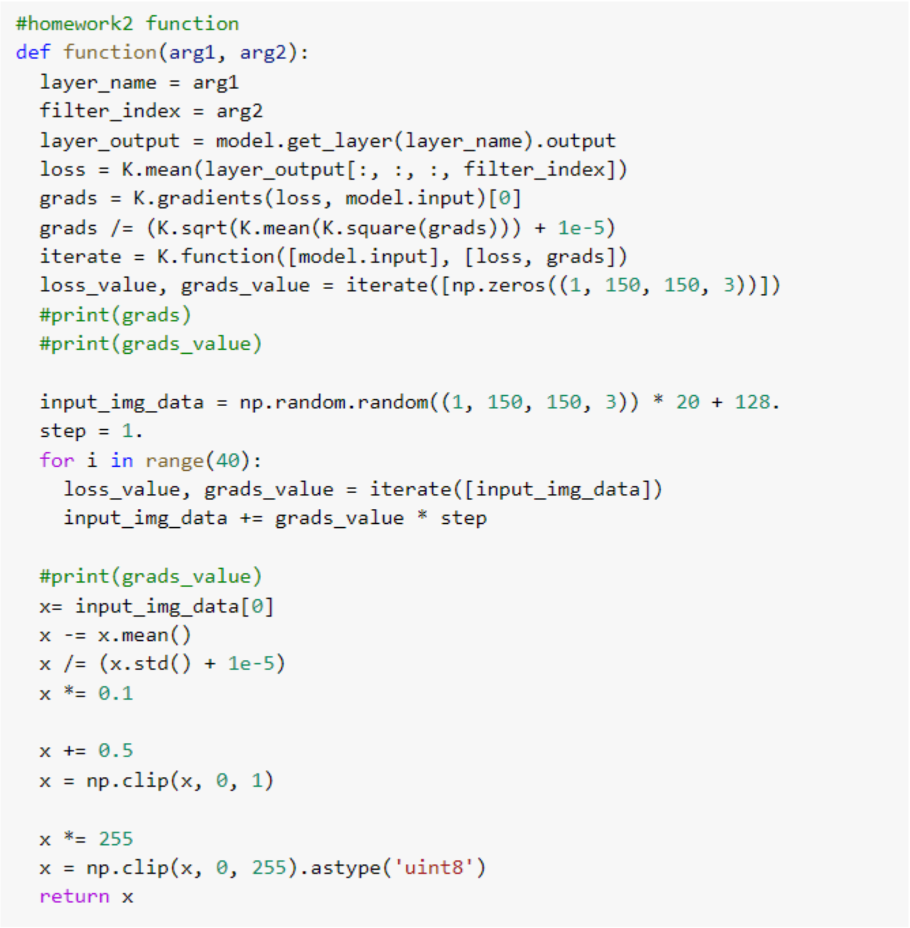
Below One can see test accuracy, which is close to original result 0.905.



```
[ ]  test_loss, test_acc = model_1.evaluate(test_images_conv, test_labels)
     print(test_loss, test_acc)

     0.36496921578049657 0.9015
```

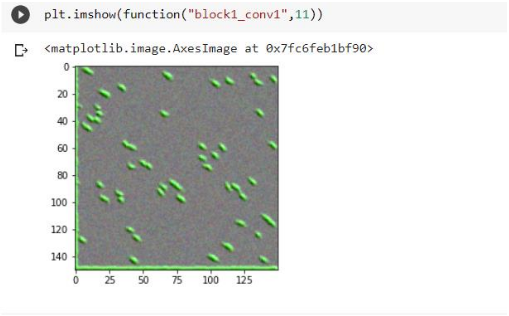
Homework 2

Below I present a function that takes as arguments the name of the layer and filter index and outputs the displayable filter response.

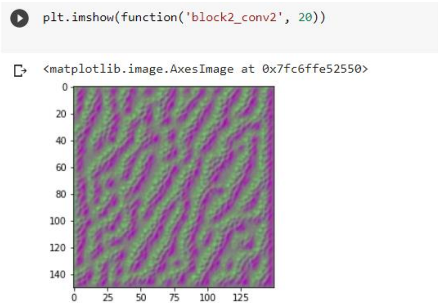


```
#homework2 function
def function(arg1, arg2):
  layer_name = arg1
  filter_index = arg2
  layer_output = model.get_layer(layer_name).output
  loss = K.mean(layer_output[:, :, :, filter_index])
  grads = K.gradients(loss, model.input)[0]
  grads /= (K.sqrt(K.mean(K.square(grads))) + 1e-5)
  iterate = K.function([model.input], [loss, grads])
  loss_value, grads_value = iterate([np.zeros((1, 150, 150, 3))])
  #print(grads)
  #print(grads_value)

  input_img_data = np.random.random((1, 150, 150, 3)) * 20 + 128.
  step = 1.
  for i in range(40):
    loss_value, grads_value = iterate([input_img_data])
    input_img_data += grads_value * step

  #print(grads_value)
  x= input_img_data[0]
  x -= x.mean()
  x /= (x.std() + 1e-5)
  x *= 0.1

  x += 0.5
  x = np.clip(x, 0, 1)

  x *= 255
  x = np.clip(x, 0, 255).astype('uint8')
  return x
```

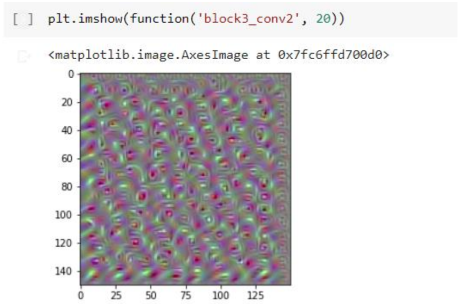
Filter response examples



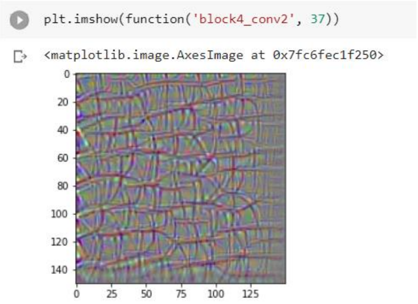
```
plt.imshow(function("block1_conv1",11))
<matplotlib.image.AxesImage at 0x7fc6feb1bf90>
```



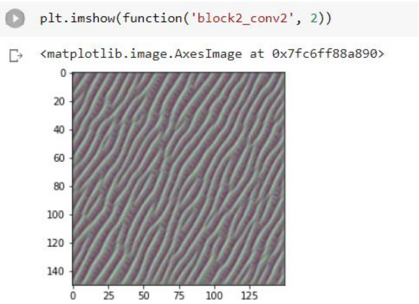
```
plt.imshow(function('block2_conv2', 20))
<matplotlib.image.AxesImage at 0x7fc6ffe52550>
```



```
[ ] plt.imshow(function('block3_conv2', 20))
<matplotlib.image.AxesImage at 0x7fc6ffd700d0>
```



```
plt.imshow(function('block4_conv2', 37))
<matplotlib.image.AxesImage at 0x7fc6fec1f250>
```



```
plt.imshow(function('block2_conv2', 2))
<matplotlib.image.AxesImage at 0x7fc6ff88a890>
```