Assignment 6.1: MNIST

In [27]:

```
import pandas as pd
import matplotlib.pyplot as plt

from keras import layers
from keras import models
from tensorflow.keras.utils import to_categorical

from keras.datasets import mnist
```

Initiating a Convnet

In [2]:

```
model = models.Sequential()
model.add(layers.Conv2D(32,(3,3), activation='relu', input_shape=(28, 28, 1)
model.add(layers.MaxPooling2D((2,2)))
model.add(layers.Conv2D(64,(3,3), activation='relu'))
model.add(layers.MaxPooling2D((2,2)))
model.add(layers.Conv2D(64,(3,3), activation='relu'))
```

Adding a Classifier

In [4]:

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

In [5]:

```
model.summary()
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #   
=================================================================
 conv2d (Conv2D)             (None, 26, 26, 32)        320       
                                                                 
 max_pooling2d (MaxPooling2D  (None, 13, 13, 32)       0         
 )                                                               
                                                                 
 conv2d_1 (Conv2D)           (None, 11, 11, 64)        18496     
                                                                 
 max_pooling2d_1 (MaxPooling  (None, 5, 5, 64)         0         
 2D)                                                             
                                                                 
 conv2d_2 (Conv2D)           (None, 3, 3, 64)          36928     
                                                                 
 flatten (Flatten)           (None, 576)               0         
                                                                 
 dense (Dense)               (None, 64)                36928     
                                                                 
 dense_1 (Dense)             (None, 10)                650       
                                                                 
=================================================================
Total params: 93,322
Trainable params: 93,322
Non-trainable params: 0
_________________________________________________________________
```

Training Convnet on MNIST Data

In [8]:

```python
(train_images, train_labels), (test_images, test_labels) = mnist.load_data()
```

In [9]:

```python
train_images = train_images.reshape((60000, 28, 28, 1))
train_images = train_images.astype('float32') / 255

test_images = test_images.reshape((10000, 28, 28, 1))
test_images = test_images.astype('float32') / 255

train_labels = to_categorical(train_labels)
test_labels = to_categorical(test_labels)
```

In [10]:

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

In [11]:

```python
model.fit(train_images, train_labels, epochs=5, batch_size=64)
```

```
Epoch 1/5
938/938 [==============================] - 40s 42ms/step - loss: 0.1747 - a
ccuracy: 0.9446
Epoch 2/5
938/938 [==============================] - 46s 49ms/step - loss: 0.0480 - a
ccuracy: 0.9851
Epoch 3/5
938/938 [==============================] - 38s 41ms/step - loss: 0.0324 - a
ccuracy: 0.9904
Epoch 4/5
938/938 [==============================] - 40s 43ms/step - loss: 0.0246 - a
ccuracy: 0.9921
Epoch 5/5
938/938 [==============================] - 43s 46ms/step - loss: 0.0185 - a
ccuracy: 0.9944
```

Out[11]:

```
<keras.callbacks.History at 0x7fec10857cd0>
```

Saving the Model

In [12]:

```python
model.save('results/model-6-1')
```

```
INFO:tensorflow:Assets written to: results/model-6-1/assets
```

Saving the Predictions

In [19]:

```python
pred = model.predict(test_images)

pred = pd.DataFrame(pred)
pred.to_csv('results/model-6-1/predictions.csv')
```

Saving the Metrics

In [23]:

```python
test_loss, test_acc = model.evaluate(test_images, test_labels)
```

```
313/313 [==============================] - 2s 6ms/step - loss: 0.0331 - acc
uracy: 0.9903
```

In [24]:

```python
print("Test Accuracy: ", test_acc)
print("Test Loss: ", test_loss)
```

```
Test Accuracy:  0.9902999997138977
Test Loss:  0.03312191739678383
```

In [25]:

```python
lines = ['Test Accuracy:  0.9902999997138977', 'Test Loss:  0.03312191739678
```

In [26]:

```python
with open('results/model-6-1/metrics.txt', 'w') as f:
    f.write('\n'.join(lines))
```

Saving the Validation Plots

In [28]:

```python
history = model.fit(train_images, train_labels, epochs=5, batch_size=64)
```

```
Epoch 1/5
938/938 [==============================] - 46s 49ms/step - loss: 0.0151 - a
ccuracy: 0.9953
Epoch 2/5
938/938 [==============================] - 42s 44ms/step - loss: 0.0124 - a
ccuracy: 0.9963
Epoch 3/5
938/938 [==============================] - 40s 43ms/step - loss: 0.0102 - a
ccuracy: 0.9970
Epoch 4/5
938/938 [==============================] - 37s 39ms/step - loss: 0.0093 - a
ccuracy: 0.9972
Epoch 5/5
938/938 [==============================] - 38s 40ms/step - loss: 0.0073 - a
ccuracy: 0.9977
```

In [34]:

```
acc = history.history['accuracy']
loss = history.history['loss']
```

In [40]:

```
history.history
```

Out[40]:

```
{'loss': [0.01508525013923645,
  0.012374487705528736,
  0.010205096565186977,
  0.009319016709923744,
  0.007304158993065357],
 'accuracy': [0.9953166842460632,
  0.9962666630744934,
  0.9969666600227356,
  0.9972166419029236,
  0.9977499842643738]}
```

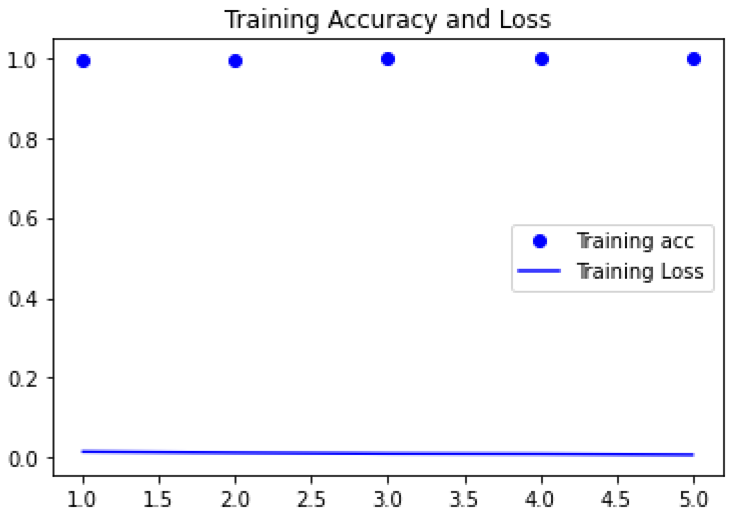
In [35]:

```
epochs = range(1, len(acc) + 1)
```

In [37]:

```
plt.plot(epochs, acc, 'bo', label='Training acc')
plt.plot(epochs, loss, 'b', label='Training Loss')
plt.title('Training Accuracy and Loss')
plt.legend()

plt.show()
```



```
In [41]: plt.savefig('results/model-6-1/validationplot.jpg')
```

```
<Figure size 432x288 with 0 Axes>
```