

Assignment_6.2a

July 15, 2021

```
[1]: from keras.datasets import cifar10
      from keras.utils import to_categorical
      import pandas as pd

      (x_train, y_train), (x_test, y_test) = cifar10.load_data()
```

Downloading data from <https://www.cs.toronto.edu/~kriz/cifar-10-python.tar.gz>
170500096/170498071 [=====] - 19s 0us/step

```
[2]: x_train.shape, y_train.shape
```

```
[2]: ((50000, 32, 32, 3), (50000, 1))
```

```
[3]: x_test.shape, y_test.shape
```

```
[3]: ((10000, 32, 32, 3), (10000, 1))
```

```
[4]: # Preprocess the data (these are NumPy arrays)
      x_train = x_train.astype("float32") / 255
      x_test = x_test.astype("float32") / 255

      y_train = to_categorical(y_train)
      y_test = to_categorical(y_test)

      # Reserve 10,000 samples for validation
      x_val = x_train[-10000:]
      y_val = y_train[-10000:]
      x_train = x_train[:-10000]
      y_train = y_train[:-10000]
```

```
[5]: x_val.shape, y_val.shape
```

```
[5]: ((10000, 32, 32, 3), (10000, 10))
```

```
[6]: #instantiate the model
      from keras import models
      from keras import layers
```

```

model = models.Sequential()
model.add(layers.Conv2D(32, (3,3), activation='relu', input_shape=(32,32,3)))
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'))
model.add(layers.MaxPooling2D(2,2))
model.add(layers.Flatten())
model.add(layers.Dense(64, activation='relu'))
model.add(layers.Dense(10, activation='softmax'))

model.summary()

```

Model: "sequential"

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 30, 30, 32)	896
max_pooling2d (MaxPooling2D)	(None, 15, 15, 32)	0
conv2d_1 (Conv2D)	(None, 13, 13, 64)	18496
max_pooling2d_1 (MaxPooling2D)	(None, 6, 6, 64)	0
conv2d_2 (Conv2D)	(None, 4, 4, 64)	36928
max_pooling2d_2 (MaxPooling2D)	(None, 2, 2, 64)	0
flatten (Flatten)	(None, 256)	0
dense (Dense)	(None, 64)	16448
dense_1 (Dense)	(None, 10)	650

Total params: 73,418
 Trainable params: 73,418
 Non-trainable params: 0

```

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

history = model.fit(x_train, y_train, epochs=100, validation_data=(x_val,
↪y_val), verbose=0)

```

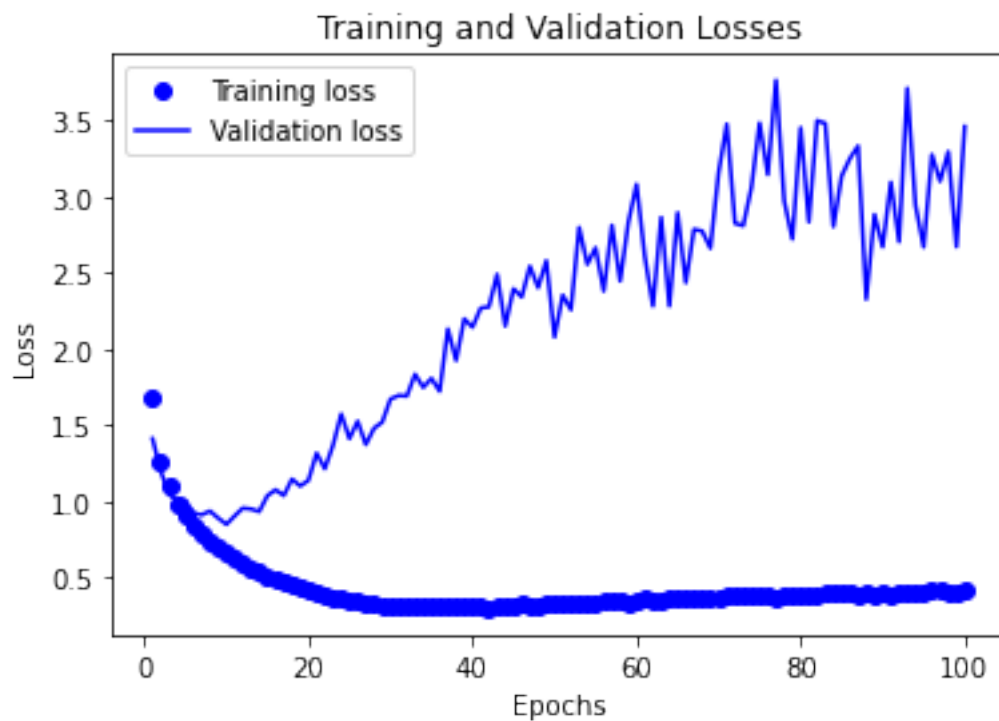
```
[8]: import matplotlib.pyplot as plt

train_loss = history.history['loss']
val_loss = history.history['val_loss']

epochs = range(1, len(history.history['loss']) + 1)

plt.plot(epochs, train_loss, 'bo', label='Training loss')
plt.plot(epochs, val_loss, 'b', label='Validation loss')
plt.title('Training and Validation Losses')
plt.xlabel('Epochs')
plt.ylabel('Loss')
plt.legend()

plt.show()
plt.savefig('results/6_2a_lossplot.png')
```



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```
[9]: import matplotlib.pyplot as plt

train_loss = history.history['accuracy']
val_loss = history.history['val_accuracy']
```

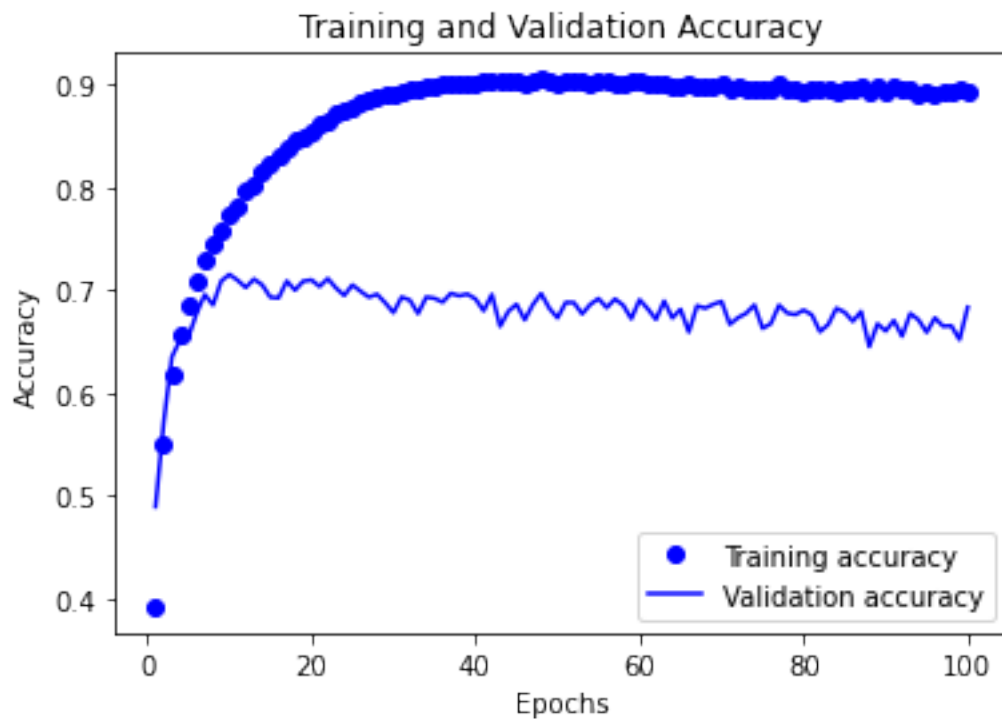
```

epochs = range(1, len(history.history['accuracy']) + 1)

plt.plot(epochs, train_loss, 'bo', label='Training accuracy')
plt.plot(epochs, val_loss, 'b', label='Validation accuracy')
plt.title('Training and Validation Accuracy')
plt.xlabel('Epochs')
plt.ylabel('Accuracy')
plt.legend()

plt.show()
plt.savefig('results/6_2a_accplot.png')

```



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```

[10]: #retrain the model and evaluate on test
(x_train, y_train), (x_test, y_test) = cifar10.load_data()

# Preprocess the data (these are NumPy arrays)
x_train = x_train.astype("float32") / 255
x_test = x_test.astype("float32") / 255

y_train = to_categorical(y_train)
y_test = to_categorical(y_test)

```

```

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

history = model.fit(x_train, y_train, epochs=10)
results = model.evaluate(x_test, y_test)

```

```

Epoch 1/10
1563/1563 [=====] - 17s 11ms/step - loss: 0.9040 -
accuracy: 0.7781
Epoch 2/10
1563/1563 [=====] - 17s 11ms/step - loss: 0.8022 -
accuracy: 0.7786
Epoch 3/10
1563/1563 [=====] - 17s 11ms/step - loss: 0.7486 -
accuracy: 0.7829
Epoch 4/10
1563/1563 [=====] - 17s 11ms/step - loss: 0.7233 -
accuracy: 0.7816
Epoch 5/10
1563/1563 [=====] - 17s 11ms/step - loss: 0.7085 -
accuracy: 0.7836
Epoch 6/10
1563/1563 [=====] - 17s 11ms/step - loss: 0.6974 -
accuracy: 0.7836
Epoch 7/10
1563/1563 [=====] - 17s 11ms/step - loss: 0.6689 -
accuracy: 0.7920
Epoch 8/10
1563/1563 [=====] - 16s 11ms/step - loss: 0.6699 -
accuracy: 0.7815
Epoch 9/10
1563/1563 [=====] - 17s 11ms/step - loss: 0.6819 -
accuracy: 0.7905
Epoch 10/10
1563/1563 [=====] - 17s 11ms/step - loss: 0.6468 -
accuracy: 0.7931
313/313 [=====] - 2s 4ms/step - loss: 1.9938 -
accuracy: 0.6462

```

```
[11]: model.save('results/6_2a_model.h5')
```

```
[12]: prediction_results = model.predict(x_test)
```

```
[13]: #write metrics to file
with open('results/6_2a_metrics.txt', 'w') as f:
```

```
f.write('Training Loss: {}'.format(str(history.history['loss'])))  
f.write('\nTraining Accuracy: {}'.format(str(history.history['accuracy'])))  
f.write('\nTest Loss: {}'.format(results[0]))  
f.write('\nTest Accuracy: {}'.format(results[1]))
```

```
[14]: predictions = pd.DataFrame(prediction_results,   
    ↪ columns=['0', '1', '2', '3', '4', '5', '6', '7', '8', '9'])  
predictions.to_csv('results/6_2a_predictions.csv', index=False)
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