Assignment 5.1

In [1]:
```
# load necessary libraries
from keras.datasets import imdb
import numpy as np

import matplotlib.pyplot as plt
```

In [2]:
```
#Loading the IMDB Dataset
(train_data, train_labels), (test_data, test_labels) = imdb.load_data(num_words=10000)
```

In [3]:
```
print(train_data[0],'\n\n----------', train_labels[0],'\n\n----------',test_data[0],'\n\
```

```
[1, 14, 22, 16, 43, 530, 973, 1622, 1385, 65, 458, 4468, 66, 3941, 4, 173, 36, 256, 5, 2
5, 100, 43, 838, 112, 50, 670, 2, 9, 35, 480, 284, 5, 150, 4, 172, 112, 167, 2, 336, 38
5, 39, 4, 172, 4536, 1111, 17, 546, 38, 13, 447, 4, 192, 50, 16, 6, 147, 2025, 19, 14, 2
2, 4, 1920, 4613, 469, 4, 22, 71, 87, 12, 16, 43, 530, 38, 76, 15, 13, 1247, 4, 22, 17,
515, 17, 12, 16, 626, 18, 2, 5, 62, 386, 12, 8, 316, 8, 106, 5, 4, 2223, 5244, 16, 480,
66, 3785, 33, 4, 130, 12, 16, 38, 619, 5, 25, 124, 51, 36, 135, 48, 25, 1415, 33, 6, 22,
12, 215, 28, 77, 52, 5, 14, 407, 16, 82, 2, 8, 4, 107, 117, 5952, 15, 256, 4, 2, 7, 376
6, 5, 723, 36, 71, 43, 530, 476, 26, 400, 317, 46, 7, 4, 2, 1029, 13, 104, 88, 4, 381, 1
5, 297, 98, 32, 2071, 56, 26, 141, 6, 194, 7486, 18, 4, 226, 22, 21, 134, 476, 26, 480,
5, 144, 30, 5535, 18, 51, 36, 28, 224, 92, 25, 104, 4, 226, 65, 16, 38, 1334, 88, 12, 1
6, 283, 5, 16, 4472, 113, 103, 32, 15, 16, 5345, 19, 178, 32]

---------- 1

---------- [1, 591, 202, 14, 31, 6, 717, 10, 10, 2, 2, 5, 4, 360, 7, 4, 177, 5760, 394,
354, 4, 123, 9, 1035, 1035, 1035, 10, 10, 13, 92, 124, 89, 488, 7944, 100, 28, 1668, 14,
31, 23, 27, 7479, 29, 220, 468, 8, 124, 14, 286, 170, 8, 157, 46, 5, 27, 239, 16, 179,
2, 38, 32, 25, 7944, 451, 202, 14, 6, 717]

---------- 0
```

In [4]:
```
train_labels[0]
```

Out[4]:
```
1
```

In [5]:
```
# Test to see a review
word_index = imdb.get_word_index()
reverse_word_index = dict([(value, key) for (key, value) in word_index.items()]) # Rever
decoded_review = ' '.join([reverse_word_index.get(i - 3, '?') for i in train_data[0]])
```

In [6]:
```
decoded_review
```

Out[6]:
```
"? this film was just brilliant casting location scenery story direction everyone's real
ly suited the part they played and you could just imagine being there robert ? is an ama
zing actor and now the same being director ? father came from the same scottish island a
s myself so i loved the fact there was a real connection with this film the witty remark
s throughout the film were great it was just brilliant so much that i bought the film as
soon as it was released for ? and would recommend it to everyone to watch and the fly fi
shing was amazing really cried at the end it was so sad and you know what they say if yo
u cry at a film it must have been good and this definitely was also ? to the two little
boy's that played the ? of norman and paul they were just brilliant children are often l
eft out of the ? list i think because the stars that play them all grown up are such a b
ig profile for the whole film but these children are amazing and should be praised for w
hat they have done don't you think the whole story was so lovely because it was true and
was someone's life after all that was shared with us all"
```

In [7]:
```
# Encoding the integer sequences into a binary matrix
```

```
def vectorize_sequences(sequences, dimension=10000):
    results = np.zeros((len(sequences), dimension))
    for i, sequence in enumerate(sequences):
        results[i, sequence] = 1.
    return results

x_train = vectorize_sequences(train_data)
x_test = vectorize_sequences(test_data)
```

In [8]:
```
# sample train data
x_train[0]
```

Out[8]:
```
array([0., 1., 1., ..., 0., 0., 0.])
```

In [9]:
```
#Vectorize the label
y_train = np.asarray(train_labels).astype('float32')
y_test = np.asarray(test_labels).astype('float32')
```

In [10]:
```
# The model definition
#The Keras implementation
from keras import models
from keras import layers

model = models.Sequential()
model.add(layers.Dense(16, activation='relu', input_shape=(10000,)))
model.add(layers.Dense(16, activation='relu'))
model.add(layers.Dense(1, activation='sigmoid'))
```

In [11]:
```
# Compiling the model
model.compile(optimizer='rmsprop',
loss='binary_crossentropy',
metrics=['accuracy'])
```

In [12]:
```
# Configuring the optimizer
from keras import optimizers
model.compile(optimizer=optimizers.RMSprop(learning_rate=0.001),
loss='binary_crossentropy',
metrics=['accuracy'])
from keras import losses
from keras import metrics
model.compile(optimizer=optimizers.RMSprop(learning_rate=0.001),
loss=losses.binary_crossentropy,
metrics=[metrics.binary_accuracy])
```

In [13]:
```
# Setting aside a validation set
x_val = x_train[:10000]
partial_x_train = x_train[10000:]
y_val = y_train[:10000]
partial_y_train = y_train[10000:]
```

In [14]:
```
# Training the model
#model.compile(optimizer='rmsprop',loss='binary_crossentropy',metrics=['accuracy'])
history = model.fit(partial_x_train,
partial_y_train,
epochs=20,
batch_size=512,
validation_data=(x_val, y_val))
```

```
Epoch 1/20
30/30 [==============================] - 4s 87ms/step - loss: 0.5127 - binary_accuracy:
0.7836 - val_loss: 0.3793 - val_binary_accuracy: 0.8728
Epoch 2/20
30/30 [==============================] - 1s 22ms/step - loss: 0.3007 - binary_accuracy:
```

```
0.9037 - val_loss: 0.3005 - val_binary_accuracy: 0.8883
Epoch 3/20
30/30 [==============================] - 1s 22ms/step - loss: 0.2209 - binary_accuracy:
0.9281 - val_loss: 0.2788 - val_binary_accuracy: 0.8909
Epoch 4/20
30/30 [==============================] - 1s 22ms/step - loss: 0.1722 - binary_accuracy:
0.9443 - val_loss: 0.3223 - val_binary_accuracy: 0.8695
Epoch 5/20
30/30 [==============================] - 1s 22ms/step - loss: 0.1395 - binary_accuracy:
0.9565 - val_loss: 0.3105 - val_binary_accuracy: 0.8747
Epoch 6/20
30/30 [==============================] - 1s 22ms/step - loss: 0.1164 - binary_accuracy:
0.9647 - val_loss: 0.2927 - val_binary_accuracy: 0.8839
Epoch 7/20
30/30 [==============================] - 1s 21ms/step - loss: 0.0936 - binary_accuracy:
0.9737 - val_loss: 0.3112 - val_binary_accuracy: 0.8822
Epoch 8/20
30/30 [==============================] - 1s 21ms/step - loss: 0.0765 - binary_accuracy:
0.9792 - val_loss: 0.3314 - val_binary_accuracy: 0.8819
Epoch 9/20
30/30 [==============================] - 1s 22ms/step - loss: 0.0609 - binary_accuracy:
0.9843 - val_loss: 0.3569 - val_binary_accuracy: 0.8786
Epoch 10/20
30/30 [==============================] - 1s 23ms/step - loss: 0.0528 - binary_accuracy:
0.9865 - val_loss: 0.4065 - val_binary_accuracy: 0.8747
Epoch 11/20
30/30 [==============================] - 1s 21ms/step - loss: 0.0380 - binary_accuracy:
0.9923 - val_loss: 0.4106 - val_binary_accuracy: 0.8774
Epoch 12/20
30/30 [==============================] - 1s 21ms/step - loss: 0.0296 - binary_accuracy:
0.9940 - val_loss: 0.4661 - val_binary_accuracy: 0.8657
Epoch 13/20
30/30 [==============================] - 1s 21ms/step - loss: 0.0236 - binary_accuracy:
0.9959 - val_loss: 0.4857 - val_binary_accuracy: 0.8684
Epoch 14/20
30/30 [==============================] - 1s 19ms/step - loss: 0.0201 - binary_accuracy:
0.9961 - val_loss: 0.5048 - val_binary_accuracy: 0.8713
Epoch 15/20
30/30 [==============================] - 1s 20ms/step - loss: 0.0147 - binary_accuracy:
0.9981 - val_loss: 0.5380 - val_binary_accuracy: 0.8704
Epoch 16/20
30/30 [==============================] - 1s 20ms/step - loss: 0.0104 - binary_accuracy:
0.9987 - val_loss: 0.6398 - val_binary_accuracy: 0.8628
Epoch 17/20
30/30 [==============================] - 1s 23ms/step - loss: 0.0070 - binary_accuracy:
0.9997 - val_loss: 0.6595 - val_binary_accuracy: 0.8596
Epoch 18/20
30/30 [==============================] - 1s 23ms/step - loss: 0.0094 - binary_accuracy:
0.9977 - val_loss: 0.6525 - val_binary_accuracy: 0.8681
Epoch 19/20
30/30 [==============================] - 1s 20ms/step - loss: 0.0032 - binary_accuracy:
0.9999 - val_loss: 0.6890 - val_binary_accuracy: 0.8656
Epoch 20/20
30/30 [==============================] - 1s 21ms/step - loss: 0.0057 - binary_accuracy:
0.9990 - val_loss: 0.7150 - val_binary_accuracy: 0.8655
```

In [15]:

```python
history_dict = history.history
history_dict.keys()
```

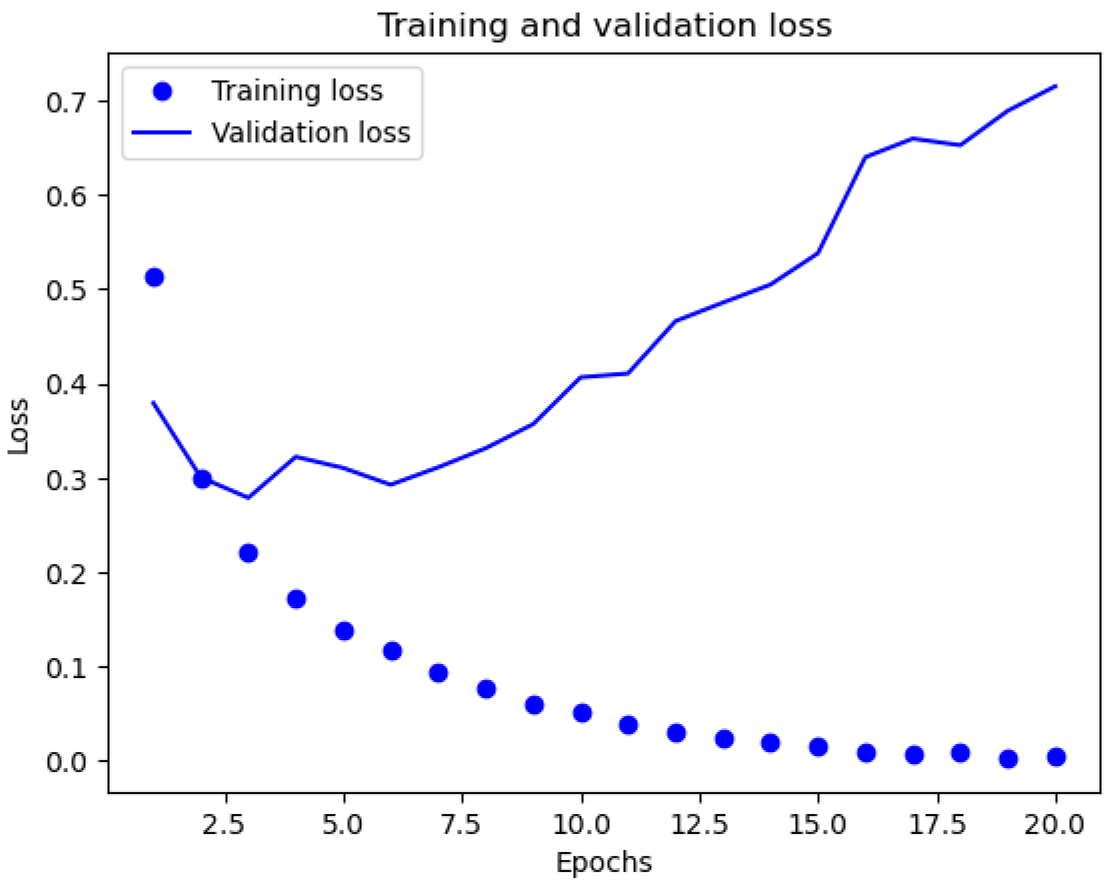
Out[15]:

```
dict_keys(['loss', 'binary_accuracy', 'val_loss', 'val_binary_accuracy'])
```

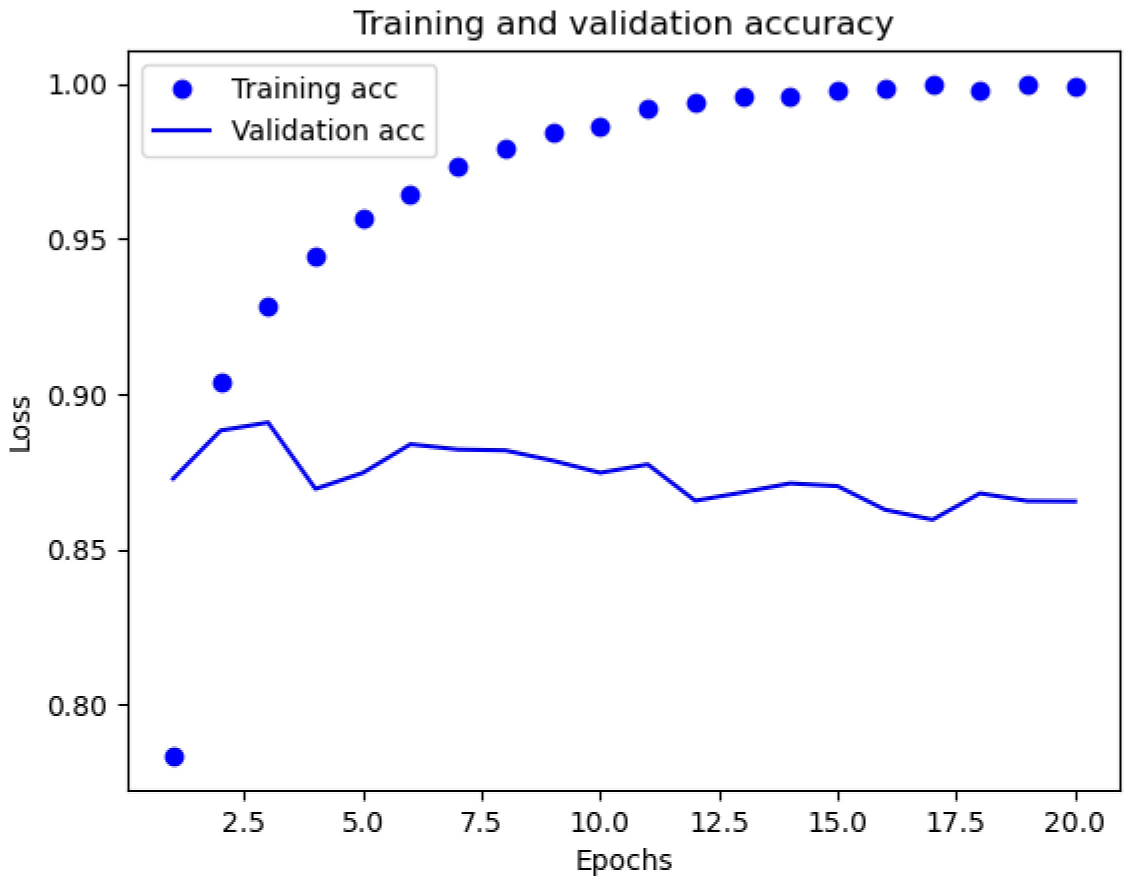
In [16]:

```python
# Plotting training and validation loss
import matplotlib.pyplot as plt
acc = history.history['binary_accuracy']
val_acc = history.history['val_binary_accuracy']
```

```
loss = history.history['loss']
val_loss = history.history['val_loss']
epochs = range(1, len(acc) + 1)
# "bo" for the "blue dot"
plt.plot(epochs, loss, 'bo', label='Training loss')
# b for the "solid blue line"
plt.plot(epochs, val_loss, 'b', label='Validation loss')
plt.title('Training and validation loss')
plt.xlabel('Epochs')
plt.ylabel('Loss')
plt.legend()
plt.show()
```



In [17]:
```
#  Plotting training and validation accuracy
plt.clf() # clear figure
acc = history.history['binary_accuracy']
val_acc = history.history['val_binary_accuracy']
plt.plot(epochs, acc, 'bo', label='Training acc')
plt.plot(epochs, val_acc, 'b', label='Validation acc')
plt.title('Training and validation accuracy')
plt.xlabel('Epochs')
plt.ylabel('Loss')
plt.legend()
plt.show()
```



In [18]:
```
#  Retraining a model from scratch

model = models.Sequential()
model.add(layers.Dense(16, activation='relu', input_shape=(10000,)))
model.add(layers.Dense(16, activation='relu'))
model.add(layers.Dense(1, activation='sigmoid'))
model.compile(optimizer='rmsprop',
loss='binary_crossentropy',
metrics=['accuracy'])

# Fit Model
model.fit(x_train, y_train, epochs=4, batch_size=512)
# Evaluate the model
results = model.evaluate(x_test, y_test)
```

```
Epoch 1/4
49/49 [==============================] - 2s 16ms/step - loss: 0.4377 - accuracy: 0.8175
Epoch 2/4
49/49 [==============================] - 1s 15ms/step - loss: 0.2590 - accuracy: 0.9067
Epoch 3/4
49/49 [==============================] - 1s 14ms/step - loss: 0.2050 - accuracy: 0.9264
Epoch 4/4
49/49 [==============================] - 1s 14ms/step - loss: 0.1744 - accuracy: 0.9369
782/782 [==============================] - 3s 4ms/step - loss: 0.2992 - accuracy: 0.8811
```

In [19]:
```
results = model.evaluate(x_test,y_test)
```

```
782/782 [==============================] - 3s 4ms/step - loss: 0.2992 - accuracy: 0.8811
```

Accuray around 88.6%

In [20]:
```
#  Using a trained network to generate predictions on new data
model.predict(x_test)
```

```
782/782 [==============================] - 3s 3ms/step
```

Out[20]:
```
array([[0.1567305 ],
```

```
[0.9989557 ],
[0.5829845 ],
...,
[0.09563804],
[0.04725974],
[0.63263386]], dtype=float32)
```