In [1]:
```
# Import tensorflow
import tensorflow as tf
```

In [2]:
```
# Load the IMDB dataset
imdb = tf.keras.datasets.imdb
```

In [3]:
```
"""The argument num_words=10000 means you’ll only keep the top 10,000 most fre-
quently occurring words in the training data. Rare words will be discarded. This allows
you to work with vector data of manageable size.
The variables train_data and test_data are lists of reviews; each review is a list of
word indices (encoding a sequence of words). train_labels and test_labels are
lists of 0s and 1s, where 0 stands for negative and 1 stands for positive:"""

(train_data, train_labels), (test_data, test_labels) = imdb.load_data(
num_words=10000)
```

In [4]:
```
train_data[0]
```

Out[4]:
```
[1,
 14,
 22,
 16,
 43,
 530,
 973,
 1622,
 1385,
 65,
 458,
 4468,
 66,
 3941,
 4,
 173,
 36,
 256,
 5,
 25,
 100,
 43,
 838,
 112,
 50,
 670,
 2,
 9,
 35,
 480,
 284,
 5,
 150,
 4,
 172,
 112,
 167,
 2,
 336,
 385,
 39,
 4,
 172,
 4536,
 1111,
 17,
 546,
 38,
 13,
 447,
 4,
 192,
 50,
 16,
 6,
 147,
 2025,
```

```
19,
14,
22,
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,
3766,
5,
723,
36,
71,
43,
530,
476,
26,
400,
317,
46,
7,
4,
2,
1029,
13,
104,
88,
4,
381,
15,
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,
 16,
 283,
 5,
 16,
 4472,
 113,
 103,
 32,
 15,
 16,
 5345,
 19,
 178,
 32]
```

In [5]:
```
train_labels[0]
```

Out[5]:
```
1
```

In [6]:
```
"""You can’t feed lists of integers into a neural network. You have t
o turn your lists into
tensors.One-hot encode your lists to turn them into vectors of 0s and
1s. This would
mean, for instance, turning the sequence [3, 5] into a 10,000-dimensi
onal vec-
tor that would be all 0s except for indices 3 and 5, which would be 1
s. Then you
could use as the first layer in your network a Dense layer, capable o
f handling
floating-point vector data."""

# Encoding the integer sequences into a binary matrix
import numpy as np

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)
y_train = np.asarray(train_labels).astype('float32')
y_test = np.asarray(test_labels).astype('float32')
```

In [7]:
```
# Here’s what the samples look like now:
x_train[0]
```

Out[7]:
```
array([0., 1., 1., ..., 0., 0., 0.])
```

In [8]:
```
"""There is more to this but for the time being, you’ll have to trust
me with the following architecture choice:"""

model = tf.keras.models.Sequential([
  tf.keras.layers.Dense(16, activation='relu', input_shape=(10000,)),
  tf.keras.layers.Dense(16, activation='relu'),
  tf.keras.layers.Dense(1, activation='sigmoid')])

"""Two intermediate layers with 16 hidden units each. And a third lay
er that will output the scalar prediction
regarding the sentiment of the current review"""

"""The intermediate layers will use relu as their activation functio
n, and the final layer
will use a sigmoid activation so as to output a probability (a score
 between 0 and 1,
indicating how likely the sample is to have the target “1”: how likel
y the review is to be
positive). A relu (rectified linear unit) is a function meant to zero
out negative values."""
```

Out[8]:
```
'The intermediate layers will use relu as their activation function,
and the final layer\nwill use a sigmoid activation so as to output a
probability (a score between 0 and 1,\nindicating how likely the samp
le is to have the target “1”: how likely the review is to be\npositiv
e). A relu (rectified linear unit) is a function meant to zero out ne
gative values.'
```

In [9]:
```
# Compiling the model
model.compile(optimizer='rmsprop', loss='binary_crossentropy', metric
s=['accuracy'])
```

In [10]:
```
# 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:]

history = model.fit(partial_x_train, partial_y_train, epochs=20,batch
_size=512,validation_data=(x_val, y_val))
```

```
Train on 15000 samples, validate on 10000 samples
Epoch 1/20
15000/15000 [==============================] - 1s 95us/sample - loss:
0.5086 - accuracy: 0.7908 - val_loss: 0.3907 - val_accuracy: 0.8665
Epoch 2/20
15000/15000 [==============================] - 1s 45us/sample - loss:
0.3096 - accuracy: 0.9007 - val_loss: 0.3097 - val_accuracy: 0.8838
Epoch 3/20
15000/15000 [==============================] - 1s 46us/sample - loss:
0.2212 - accuracy: 0.9323 - val_loss: 0.2903 - val_accuracy: 0.8841
Epoch 4/20
15000/15000 [==============================] - 1s 45us/sample - loss:
0.1786 - accuracy: 0.9424 - val_loss: 0.2878 - val_accuracy: 0.8842
Epoch 5/20
15000/15000 [==============================] - 1s 46us/sample - loss:
0.1430 - accuracy: 0.9543 - val_loss: 0.2809 - val_accuracy: 0.8860
Epoch 6/20
15000/15000 [==============================] - 1s 45us/sample - loss:
0.1151 - accuracy: 0.9657 - val_loss: 0.2991 - val_accuracy: 0.8821
Epoch 7/20
15000/15000 [==============================] - 1s 46us/sample - loss:
0.0961 - accuracy: 0.9714 - val_loss: 0.3104 - val_accuracy: 0.8822
Epoch 8/20
15000/15000 [==============================] - 1s 47us/sample - loss:
0.0775 - accuracy: 0.9785 - val_loss: 0.3295 - val_accuracy: 0.8806
Epoch 9/20
15000/15000 [==============================] - 1s 47us/sample - loss:
0.0670 - accuracy: 0.9819 - val_loss: 0.3484 - val_accuracy: 0.8812
Epoch 10/20
15000/15000 [==============================] - 1s 46us/sample - loss:
0.0523 - accuracy: 0.9879 - val_loss: 0.3731 - val_accuracy: 0.8785
Epoch 11/20
15000/15000 [==============================] - 1s 46us/sample - loss:
0.0407 - accuracy: 0.9910 - val_loss: 0.4024 - val_accuracy: 0.8742
Epoch 12/20
15000/15000 [==============================] - 1s 46us/sample - loss:
0.0325 - accuracy: 0.9941 - val_loss: 0.4276 - val_accuracy: 0.8755
Epoch 13/20
15000/15000 [==============================] - 1s 46us/sample - loss:
0.0298 - accuracy: 0.9928 - val_loss: 0.4601 - val_accuracy: 0.8717
Epoch 14/20
15000/15000 [==============================] - 1s 46us/sample - loss:
0.0214 - accuracy: 0.9962 - val_loss: 0.4809 - val_accuracy: 0.8739
Epoch 15/20
15000/15000 [==============================] - 1s 46us/sample - loss:
0.0133 - accuracy: 0.9989 - val_loss: 0.5154 - val_accuracy: 0.8707
Epoch 16/20
15000/15000 [==============================] - 1s 46us/sample - loss:
0.0156 - accuracy: 0.9975 - val_loss: 0.5494 - val_accuracy: 0.8710
Epoch 17/20
15000/15000 [==============================] - 1s 45us/sample - loss:
0.0103 - accuracy: 0.9990 - val_loss: 0.5808 - val_accuracy: 0.8681
Epoch 18/20
15000/15000 [==============================] - 1s 46us/sample - loss:
0.0057 - accuracy: 0.9997 - val_loss: 0.6203 - val_accuracy: 0.8689
Epoch 19/20
15000/15000 [==============================] - 1s 46us/sample - loss:
```

```
0.0085 - accuracy: 0.9985 - val_loss: 0.6468 - val_accuracy: 0.8672
Epoch 20/20
15000/15000 [==============================] - 1s 43us/sample - loss:
0.0032 - accuracy: 0.9999 - val_loss: 0.7158 - val_accuracy: 0.8603
```

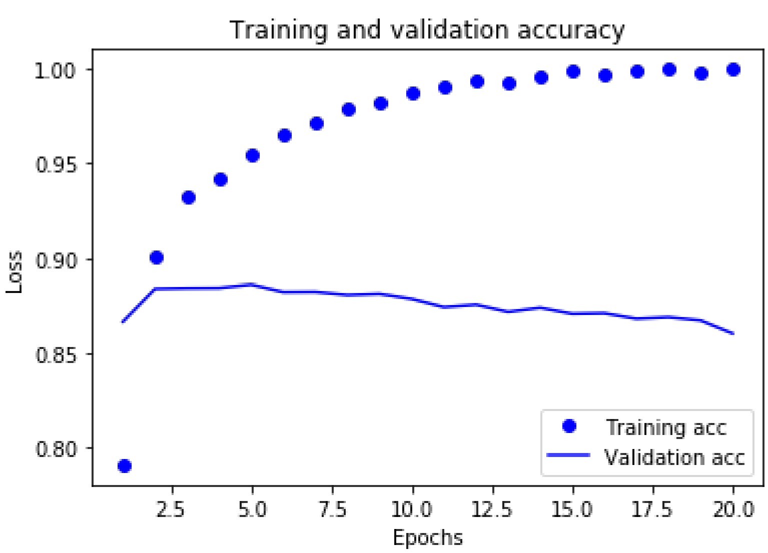
In [11]:

```python
# Plotting the training and validation loss
import matplotlib.pyplot as plt

history_dict = history.history
loss_values = history_dict['loss']
val_loss_values = history_dict['val_loss']

epochs = range(1, len(loss_values) + 1)

plt.plot(epochs, loss_values, 'bo', label='Training loss')
plt.plot(epochs, val_loss_values, 'b', label='Validation loss')
plt.title('Training and validation loss')
plt.xlabel('Epochs')
plt.ylabel('Loss')
plt.legend()

plt.show()
```

```
<matplotlib.figure.Figure at 0x7fc22ef7e3c8>
```

In [12]:

```python
# Plotting the training and validation accuracy
plt.clf()
acc_values = history_dict['accuracy']
val_acc_values = history_dict['val_accuracy']
plt.plot(epochs, acc_values, 'bo', label='Training acc')
plt.plot(epochs, val_acc_values, 'b', label='Validation acc')
plt.title('Training and validation accuracy')
plt.xlabel('Epochs')
plt.ylabel('Loss')
plt.legend()
plt.show()
```



In [17]:
```
# Retraining a model from scratch
model = tf.keras.models.Sequential([
  tf.keras.layers.Dense(16, activation='relu', input_shape=(10000,)),
  tf.keras.layers.Dense(16, activation='relu'),
  tf.keras.layers.Dense(1, activation='sigmoid')])

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

model.fit(partial_x_train, partial_y_train, epochs=4,batch_size=512,v
alidation_data=(x_val, y_val))
results = model.evaluate(x_test, y_test)
```

```
Train on 15000 samples, validate on 10000 samples
Epoch 1/4
15000/15000 [==============================] - 1s 84us/sample - loss:
0.5569 - accuracy: 0.7584 - val_loss: 0.4584 - val_accuracy: 0.8571
Epoch 2/4
15000/15000 [==============================] - 1s 46us/sample - loss:
0.3633 - accuracy: 0.8943 - val_loss: 0.3461 - val_accuracy: 0.8806
Epoch 3/4
15000/15000 [==============================] - 1s 46us/sample - loss:
0.2634 - accuracy: 0.9231 - val_loss: 0.3016 - val_accuracy: 0.8883
Epoch 4/4
15000/15000 [==============================] - 1s 44us/sample - loss:
0.2076 - accuracy: 0.9382 - val_loss: 0.2808 - val_accuracy: 0.8900
25000/25000 [==============================] - 2s 64us/sample - loss:
0.2976 - accuracy: 0.8832
```

In [18]:
```
# Using a trained network to generate predictions on new data
model.predict(x_test)
```

Out[18]:
```
array([[0.27379423],
       [0.9793424 ],
       [0.93266404],
       ...,
       [0.13444236],
       [0.17874026],
       [0.4376474 ]], dtype=float32)
```

In [ ]: