3.4 Classifying movie reviews:

a binary classification example

In [2]:
```
from keras.datasets import imdb
(train_data, train_labels), (test_data, test_labels) = imdb.load_data(
    num_words=10000)
```

```
<__array_function__ internals>:5: VisibleDeprecationWarning: Creating an ndarray from ragged nested sequences (which is a list-or-tuple of lists-or-tuples-or ndarrays with different lengths or shapes) is deprecated. If you meant to do this, you must specify 'dtype=object' when creating the ndarray
/Users/astrid/opt/anaconda3/lib/python3.8/site-packages/keras/datasets/imdb.py:155: VisibleDeprecationWarning: Creating an ndarray from ragged nested sequences (which is a list-or-tuple of lists-or-tuples-or ndarrays with different lengths or shapes) is deprecated. If you meant to do this, you must specify 'dtype=object' when creating the ndarray
  x_train, y_train = np.array(xs[:idx]), np.array(labels[:idx])
/Users/astrid/opt/anaconda3/lib/python3.8/site-packages/keras/datasets/imdb.py:156: VisibleDeprecationWarning: Creating an ndarray from ragged nested sequences (which is a list-or-tuple of lists-or-tuples-or ndarrays with different lengths or shapes) is deprecated. If you meant to do this, you must specify 'dtype=object' when creating the ndarray
  x_test, y_test = np.array(xs[idx:]), np.array(labels[idx:])
```

In [3]:
```
word_index = imdb.get_word_index()

reverse_word_index = dict([(value, key) for (key, value) in word_index.items()])

decoded_review = ' '.join([reverse_word_index.get(i - 3, '?') for i in train_data[0]])
```

In [4]:
```
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)
```

In [5]:
```
y_train = np.asarray(train_labels).astype('float32')
y_test = np.asarray(test_labels).astype('float32')
```

In [6]:
```
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 [7]:
```
model.compile(optimizer='rmsprop',
                  loss='binary_crossentropy',
                  metrics=['accuracy'])
```

In [11]:
```
#from keras import optimizers
#from tensorflow.keras import optimizers
from tensorflow import keras
from keras import optimizers

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

In [17]:
```
from keras import losses
from keras import metrics

model.compile(optimizer="rmsprop",
    loss=losses.binary_crossentropy,
    metrics=[metrics.binary_accuracy])
```

In [18]:
```
x_val = x_train[:10000]
partial_x_train = x_train[10000:]
y_val = y_train[:10000]
partial_y_train = y_train[10000:]
```

In [19]:
```
model.compile(optimizer='rmsprop',
              loss='binary_crossentropy',
              metrics=['acc'])
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 [==============================] - 14s 49ms/step - loss: 0.6045 - acc: 0.6903 - val_loss: 0.3998 - val_acc: 0.8629
Epoch 2/20
30/30 [==============================] - 0s 12ms/step - loss: 0.3357 - acc: 0.9022 - val_loss: 0.3096 - val_acc: 0.8826
Epoch 3/20
30/30 [==============================] - 0s 12ms/step - loss: 0.2252 - acc: 0.9323 - val_loss: 0.2935 - val_acc: 0.8837
Epoch 4/20
30/30 [==============================] - 0s 12ms/step - loss: 0.1768 - acc: 0.9420 - val_loss: 0.3082 - val_acc: 0.8747
Epoch 5/20
30/30 [==============================] - 0s 12ms/step - loss: 0.1437 - acc: 0.9572 - val_loss: 0.2820 - val_acc: 0.8866
Epoch 6/20
30/30 [==============================] - 0s 12ms/step - loss: 0.1201 - acc: 0.9649 - val_loss: 0.2933 - val_acc: 0.8870
Epoch 7/20
30/30 [==============================] - 0s 12ms/step - loss: 0.0971 - acc: 0.9726 - val_loss: 0.3470 - val_acc: 0.8770
Epoch 8/20
30/30 [==============================] - 0s 12ms/step - loss: 0.0874 - acc: 0.9758 - val_loss: 0.3304 - val_acc: 0.8790
Epoch 9/20
30/30 [==============================] - 0s 12ms/step - loss: 0.0670 - acc: 0.9820 - val_loss: 0.3780 - val_acc: 0.8779
Epoch 10/20
30/30 [==============================] - 0s 12ms/step - loss: 0.0522 - acc: 0.9893 - val_loss: 0.3808 - val_acc: 0.8743
Epoch 11/20
30/30 [==============================] - 0s 12ms/step - loss: 0.0452 - acc: 0.9906 - val_loss: 0.4100 - val_acc: 0.8728
Epoch 12/20
30/30 [==============================] - 0s 12ms/step - loss: 0.0399 - acc: 0.9912 - val_loss: 0.4510 - val_acc: 0.8675
Epoch 13/20
30/30 [==============================] - 0s 12ms/step - loss: 0.0309 - acc: 0.9940 - val_loss: 0.4773 - val_acc: 0.8731
Epoch 14/20
30/30 [==============================] - 0s 12ms/step - loss: 0.0234 - acc: 0.9965 - val_loss: 0.5227 - val_acc: 0.8694
Epoch 15/20
30/30 [==============================] - 0s 12ms/step - loss: 0.0185 - acc: 0.9976 - val_loss: 0.5273 - val_acc: 0.8678
Epoch 16/20
30/30 [==============================] - 0s 12ms/step - loss: 0.0146 - acc: 0.9985 - val_loss: 0.5687 - val_acc: 0.8684
Epoch 17/20
30/30 [==============================] - 0s 13ms/step - loss: 0.0102 - acc: 0.9995 - val_loss: 0.5961 - val_acc: 0.8680
Epoch 18/20
30/30 [==============================] - 0s 13ms/step - loss: 0.0115 - acc: 0.9980 - val_loss: 0.6345 - val_acc: 0.8625
Epoch 19/20
30/30 [==============================] - 0s 12ms/step - loss: 0.0066 - acc: 0.9997 - val_loss: 0.6700 - val_acc: 0.8646
Epoch 20/20
30/30 [==============================] - 0s 13ms/step - loss: 0.0049 - acc: 0.9997 - val_loss: 0.7010 - val_acc: 0.8632
```

In [27]:
```
history_dict = history.history
```

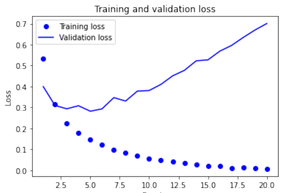
In [28]:
```
history_dict.keys()
```

Out[28]:
```
dict_keys(['loss', 'acc', 'val_loss', 'val_acc'])
```

In [30]:
```
import matplotlib.pyplot as plt

history_dict = history.history
loss_values = history_dict['loss']
val_loss_values = history_dict['val_loss']
acc = history_dict['acc']
epochs = range(1, len(acc) + 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()
```

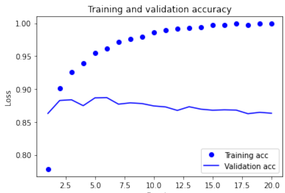


In [33]:
```
plt.clf()

acc_values = history_dict['acc']
val_acc_values = history_dict['val_acc']

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 [34]:
```
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'])
model.fit(x_train, y_train, epochs=4, batch_size=512)
results = model.evaluate(x_test, y_test)
```

```
Epoch 1/4
49/49 [==============================] - 1s 8ms/step - loss: 0.5301 - accuracy: 0.7508
Epoch 2/4
49/49 [==============================] - 0s 8ms/step - loss: 0.2604 - accuracy: 0.9114
Epoch 3/4
49/49 [==============================] - 0s 8ms/step - loss: 0.2021 - accuracy: 0.9281
Epoch 4/4
49/49 [==============================] - 0s 8ms/step - loss: 0.1613 - accuracy: 0.9454
782/782 [==============================] - 1s 1ms/step - loss: 0.3024 - accuracy: 0.8803
```

In [ ]:
```
```