```
import keras
keras.__version__
```

```
'2.12.0'
```

```
from keras.layers import Embedding

# The Embedding layer takes at least two arguments:
# the number of possible tokens, here 1000 (1 + maximum word index),
# and the dimensionality of the embeddings, here 64.
embedding_layer = Embedding(1000, 64)
```

```
from keras.datasets import imdb
from keras import preprocessing
from keras import utils as np_utils
#from tensorflow.keras.preprocessing.sequence import pad_sequences
#from keras.utils import pad_sequences
from keras.utils.data_utils import pad_sequences
# Number of words to consider as features
max_features = 10000
# Cut texts after this number of words
# (among top max_features most common words)
maxlen = 150

# Load the data as lists of integers.
(x_train, y_train), (x_test, y_test) = imdb.load_data(num_words=max_features)

# This turns our lists of integers
# into a 2D integer tensor of shape `(samples, maxlen)`
x_train = keras.utils.pad_sequences(x_train, maxlen=maxlen)
x_test = keras.utils.pad_sequences(x_test, maxlen=maxlen)
```

```
print(len(x_train))
```

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```
import numpy as np
from keras.models import Sequential
from keras.layers import Flatten, Dense

model = Sequential()
# We specify the maximum input length to our Embedding layer
# so we can later flatten the embedded inputs
model.add(Embedding(10000, 8, input_length=maxlen))
# After the Embedding layer,
# our activations have shape `(samples, maxlen, 8)`.

# We flatten the 3D tensor of embeddings
# into a 2D tensor of shape `(samples, maxlen * 8)`
model.add(Flatten())

# We add the classifier on top
model.add(Dense(1, activation='sigmoid'))
model.compile(optimizer='rmsprop', loss='binary_crossentropy', metrics=['acc'])
model.summary()

history = model.fit(x_train, y_train,
                    epochs=10,
                    batch_size=32,
                    validation_split=0.2)
```

```
Model: "sequential_8"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 embedding_11 (Embedding)    (None, 150, 8)            80000

 flatten_8 (Flatten)         (None, 1200)              0

 dense_10 (Dense)            (None, 1)                 1201

=================================================================
Total params: 81,201
Trainable params: 81,201
Non-trainable params: 0
_________________________________________________________________
```

```
Epoch 1/10
625/625 [==============================] - 27s 41ms/step - loss: 0.5914 - acc: 0.7071 - val_loss: 0.4237 - val_acc: 0.825
Epoch 2/10
625/625 [==============================] - 7s 11ms/step - loss: 0.3310 - acc: 0.8651 - val_loss: 0.3211 - val_acc: 0.865
Epoch 3/10
625/625 [==============================] - 4s 7ms/step - loss: 0.2582 - acc: 0.8963 - val_loss: 0.3031 - val_acc: 0.8730
Epoch 4/10
625/625 [==============================] - 3s 5ms/step - loss: 0.2229 - acc: 0.9134 - val_loss: 0.3024 - val_acc: 0.8712
Epoch 5/10
625/625 [==============================] - 4s 7ms/step - loss: 0.1979 - acc: 0.9254 - val_loss: 0.3042 - val_acc: 0.8722
Epoch 6/10
625/625 [==============================] - 3s 5ms/step - loss: 0.1782 - acc: 0.9338 - val_loss: 0.3102 - val_acc: 0.8694
Epoch 7/10
625/625 [==============================] - 3s 5ms/step - loss: 0.1599 - acc: 0.9426 - val_loss: 0.3176 - val_acc: 0.8696
Epoch 8/10
625/625 [==============================] - 3s 4ms/step - loss: 0.1424 - acc: 0.9495 - val_loss: 0.3258 - val_acc: 0.8694
Epoch 9/10
625/625 [==============================] - 3s 4ms/step - loss: 0.1256 - acc: 0.9581 - val_loss: 0.3365 - val_acc: 0.8656
Epoch 10/10
625/625 [==============================] - 4s 6ms/step - loss: 0.1099 - acc: 0.9640 - val_loss: 0.3530 - val_acc: 0.8630
```

```
from google.colab import drive
drive.mount('/content/gdrive')
```

```
Drive already mounted at /content/gdrive; to attempt to forcibly remount, call drive.mount("/content/gdrive", force_remou
```

```
import os
import shutil
%mkdir ../data
!wget -O ../data/aclImdb_v1.tar.gz http://ai.stanford.edu/~amaas/data/sentiment/aclImdb_v1.tar.gz
!tar -zxf ../data/aclImdb_v1.tar.gz -C ../data
imdb_dir = '/content/gdrive/MyDrive/ML Assignment 3/aclImdb'
train_dir = '/content/gdrive/MyDrive/ML Assignment 3/aclImdb/train'
#train_dir = os.path.join(imdb_dir, 'train')

labels = []
texts = []

for label_type in ['neg', 'pos']:
```

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```
            f = open(os.path.join(dir_name, fname))
            texts.append(f.read())
            f.close()
            if label_type == 'neg':
                labels.append(0)
            else:
                labels.append(1)
```

```
mkdir: cannot create directory '../data': File exists
--2023-04-16 19:11:07--  http://ai.stanford.edu/~amaas/data/sentiment/aclImdb_v1.tar.gz
Resolving ai.stanford.edu (ai.stanford.edu)... 171.64.68.10
Connecting to ai.stanford.edu (ai.stanford.edu)|171.64.68.10|:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 84125825 (80M) [application/x-gzip]
Saving to: '../data/aclImdb_v1.tar.gz'

../data/aclImdb_v1. 100%[===================>]  80.23M  67.1MB/s    in 1.2s

2023-04-16 19:11:08 (67.1 MB/s) - '../data/aclImdb_v1.tar.gz' saved [84125825/84125825]
```

```
from keras.preprocessing.text import Tokenizer
from keras.utils.data_utils import pad_sequences
#from keras.preprocessing.sequence import pad_sequences
import numpy as np

maxlen = 150  # We will cut reviews after 150 words
training_samples = 100  # We will be training on 100 samples
validation_samples = 10000  # We will be validating on 10000 samples
max_words = 10000  # We will only consider the top 10,000 words in the dataset

tokenizer = Tokenizer(num_words=max_words)
tokenizer.fit_on_texts(texts)
sequences = tokenizer.texts_to_sequences(texts)

word_index = tokenizer.word_index
print('Found %s unique tokens.' % len(word_index))

data = pad_sequences(sequences, maxlen=maxlen)
```

```
labels = np.asarray(labels)
print('Shape of data tensor:', data.shape)
print('Shape of label tensor:', labels.shape)

# Split the data into a training set and a validation set
# But first, shuffle the data, since we started from data
# where sample are ordered (all negative first, then all positive).
indices = np.arange(data.shape[0])
np.random.shuffle(indices)
data = data[indices]
labels = labels[indices]

x_train = data[:training_samples]
y_train = labels[:training_samples]
x_val = data[training_samples: training_samples + validation_samples]
y_val = labels[training_samples: training_samples + validation_samples]
```

```
Found 88582 unique tokens.
Shape of data tensor: (25000, 150)
Shape of label tensor: (25000,)
```

```
import os
import numpy as np
from keras.preprocessing.text import Tokenizer
from keras.utils.data_utils import pad_sequences
glove_dir = '/content/gdrive/MyDrive/ML Assignment 3/glove6B'

embeddings_index = {}
f = open(os.path.join(glove_dir, 'glove.6B.100d.txt'))
for line in f:
    values = line.split()
    word = values[0]
    coefs = np.asarray(values[1:], dtype='float32')
    embeddings_index[word] = coefs
f.close()

print('Found %s word vectors.' % len(embeddings_index))
```

```
Found 400001 word vectors.
```

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```
embedding_dim = 100
max_words = 10000
tokenizer = Tokenizer(num_words=max_words)

word_index = tokenizer.word_index
print('Found %s unique tokens.' % len(word_index))
embedding_matrix = np.zeros((max_words, embedding_dim))
for word, i in word_index.items():
    embedding_vector = embeddings_index.get(word)
    if i < max_words:
        if embedding_vector is not None:
            # Words not found in embedding index will be all-zeros.
            embedding_matrix[i] = embedding_vector
```

```
Found 0 unique tokens.
```

```
from keras.models import Sequential
from keras.layers import Embedding, Flatten, Dense
maxlen = 150
model = Sequential()
model.add(Embedding(max_words, embedding_dim, input_length=maxlen))
model.add(Flatten())
model.add(Dense(32, activation='relu'))
model.add(Dense(1, activation='sigmoid'))
model.summary()
```

```
Model: "sequential_9"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 embedding_12 (Embedding)    (None, 150, 100)          1000000

 flatten_9 (Flatten)         (None, 15000)             0

 dense_11 (Dense)            (None, 32)                480032

 dense_12 (Dense)            (None, 1)                 33

=================================================================
Total params: 1,480,065
```

```
Trainable params: 1,480,065
Non-trainable params: 0
_________________________________________________________________
```

```
model.layers[0].set_weights([embedding_matrix])
model.layers[0].trainable = False


model.compile(optimizer='rmsprop',
              loss='binary_crossentropy',
              metrics=['acc'])
history = model.fit(x_train, y_train,
                    epochs=10,
                    batch_size=32,
                    validation_data=(x_val, y_val))
model.save_weights('pre_trained_glove_model.h5')
```

```
Epoch 1/10
4/4 [==============================] - 2s 353ms/step - loss: 0.6929 - acc: 0.5900 - val_loss: 0.6931 - val_acc: 0.5060
Epoch 2/10
4/4 [==============================] - 1s 196ms/step - loss: 0.6923 - acc: 0.5900 - val_loss: 0.6931 - val_acc: 0.5060
Epoch 3/10
4/4 [==============================] - 1s 218ms/step - loss: 0.6921 - acc: 0.5900 - val_loss: 0.6931 - val_acc: 0.5060
Epoch 4/10
4/4 [==============================] - 1s 218ms/step - loss: 0.6921 - acc: 0.5900 - val_loss: 0.6931 - val_acc: 0.5060
Epoch 5/10
4/4 [==============================] - 1s 290ms/step - loss: 0.6919 - acc: 0.5900 - val_loss: 0.6931 - val_acc: 0.5060
Epoch 6/10
4/4 [==============================] - 1s 289ms/step - loss: 0.6918 - acc: 0.5900 - val_loss: 0.6931 - val_acc: 0.5060
Epoch 7/10
4/4 [==============================] - 1s 290ms/step - loss: 0.6916 - acc: 0.5900 - val_loss: 0.6931 - val_acc: 0.5060
Epoch 8/10
4/4 [==============================] - 1s 437ms/step - loss: 0.6914 - acc: 0.5900 - val_loss: 0.6931 - val_acc: 0.5060
Epoch 9/10
4/4 [==============================] - 1s 219ms/step - loss: 0.6912 - acc: 0.5900 - val_loss: 0.6931 - val_acc: 0.5060
Epoch 10/10
4/4 [==============================] - 1s 219ms/step - loss: 0.6910 - acc: 0.5900 - val_loss: 0.6931 - val_acc: 0.5060
```

```
import matplotlib.pyplot as plt

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

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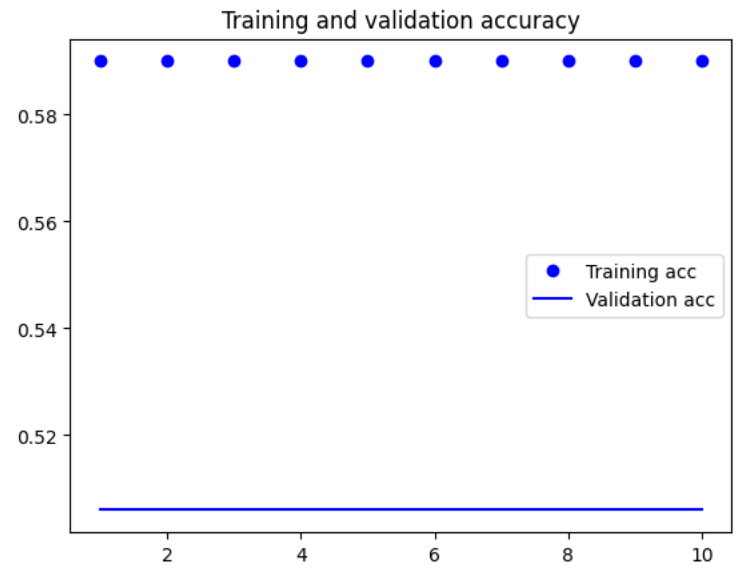
```
val_loss = history.history['val_loss']

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

plt.plot(epochs, acc, 'bo', label='Training acc')
plt.plot(epochs, val_acc, 'b', label='Validation acc')
plt.title('Training and validation accuracy')
plt.legend()

plt.figure()

plt.plot(epochs, loss, 'bo', label='Training loss')
plt.plot(epochs, val_loss, 'b', label='Validation loss')
plt.title('Training and validation loss')
plt.legend()

plt.show()
```




```
test_dir = os.path.join(imdb_dir, 'test')

labels = []
texts = []

for label_type in ['neg', 'pos']:
    dir_name = os.path.join(test_dir, label_type)
    for fname in sorted(os.listdir(dir_name)):
        if fname[-4:] == '.txt':
            f = open(os.path.join(dir_name, fname))
            texts.append(f.read())
            f.close()
            if label_type == 'neg':
                labels.append(0)
            else:
                labels.append(1)
```

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```
x_test = pad_sequences(sequences, maxlen=maxlen)
y_test = np.asarray(labels)
```

2 4 6 8 10

```
model.load_weights('pre_trained_glove_model.h5')
model.evaluate(x_test, y_test)
```

```
785/785 [==============================] - 2s 3ms/step - loss: 0.6933 - acc: 0.4979
[0.6932905316352844, 0.49794843792915344]
```

Hypertuning Embedding Layer 1 - 1000 Samples

```
import keras
keras.__version__
```

```
'2.12.0'
```

```
from keras.layers import Embedding

# The Embedding layer takes at least two arguments:
# the number of possible tokens, here 1000 (1 + maximum word index),
# and the dimensionality of the embeddings, here 64.
embedding_layer = Embedding(1000, 64)
```

```
from keras.datasets import imdb
from keras import preprocessing
from keras.utils.data_utils import pad_sequences

# Number of words to consider as features
max_features = 10000
# Cut texts after this number of words
# (among top max_features most common words)
maxlen = 150

# Load the data as lists of integers.
(x_train, y_train), (x_test, y_test) = imdb.load_data(num_words=max_features)
```

```
x_train = x_train[:1000]
y_train = y_train[:1000]

# This turns our lists of integers
# into a 2D integer tensor of shape `(samples, maxlen)`
x_train = keras.utils.pad_sequences(x_train, maxlen=maxlen)
x_test = keras.utils.pad_sequences(x_test, maxlen=maxlen)
```

```
print(len(x_train))
```

```
1000
```

```
from keras.models import Sequential
from keras.layers import Flatten, Dense

model = Sequential()
# We specify the maximum input length to our Embedding layer
# so we can later flatten the embedded inputs
model.add(Embedding(10000, 8, input_length=maxlen))
# After the Embedding layer,
# our activations have shape `(samples, maxlen, 8)`.

# We flatten the 3D tensor of embeddings
# into a 2D tensor of shape `(samples, maxlen * 8)`
model.add(Flatten())

# We add the classifier on top
model.add(Dense(1, activation='sigmoid'))
model.compile(optimizer='rmsprop', loss='binary_crossentropy', metrics=['acc'])
model.summary()

history = model.fit(x_train, y_train,
                    epochs=10,
                    batch_size=32,
```

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```
 Layer (type)                Output Shape              Param #   
=================================================================
 embedding_14 (Embedding)    (None, 150, 8)            80000     
                                                                 
 flatten_10 (Flatten)        (None, 1200)              0         
                                                                 
 dense_13 (Dense)            (None, 1)                 1201      
                                                                 
=================================================================
Total params: 81,201
Trainable params: 81,201
Non-trainable params: 0
_________________________________________________________________
Epoch 1/10
25/25 [==============================] - 3s 110ms/step - loss: 0.6939 - acc: 0.5000 - val_loss: 0.6921 - val_acc: 0.5200
Epoch 2/10
25/25 [==============================] - 3s 127ms/step - loss: 0.6771 - acc: 0.7563 - val_loss: 0.6904 - val_acc: 0.5250
Epoch 3/10
25/25 [==============================] - 3s 105ms/step - loss: 0.6607 - acc: 0.8712 - val_loss: 0.6887 - val_acc: 0.5250
Epoch 4/10
25/25 [==============================] - 2s 73ms/step - loss: 0.6401 - acc: 0.9250 - val_loss: 0.6865 - val_acc: 0.5100
Epoch 5/10
25/25 [==============================] - 2s 67ms/step - loss: 0.6147 - acc: 0.9400 - val_loss: 0.6837 - val_acc: 0.5350
Epoch 6/10
25/25 [==============================] - 1s 53ms/step - loss: 0.5843 - acc: 0.9500 - val_loss: 0.6804 - val_acc: 0.5500
Epoch 7/10
25/25 [==============================] - 1s 40ms/step - loss: 0.5490 - acc: 0.9613 - val_loss: 0.6763 - val_acc: 0.5600
Epoch 8/10
25/25 [==============================] - 1s 41ms/step - loss: 0.5095 - acc: 0.9712 - val_loss: 0.6717 - val_acc: 0.5800
Epoch 9/10
25/25 [==============================] - 1s 31ms/step - loss: 0.4666 - acc: 0.9725 - val_loss: 0.6665 - val_acc: 0.5900
Epoch 10/10
25/25 [==============================] - 1s 44ms/step - loss: 0.4218 - acc: 0.9812 - val_loss: 0.6611 - val_acc: 0.6050
```

800 Samples

```
from keras.datasets import imdb
from keras import preprocessing
from keras.utils.data_utils import pad_sequences

# Number of words to consider as features
max_features = 10000
# Cut texts after this number of words
# (among top max_features most common words)
maxlen = 150

# Load the data as lists of integers.
(x_train, y_train), (x_test, y_test) = imdb.load_data(num_words=max_features)

x_train = x_train[:800]
y_train = y_train[:800]

# This turns our lists of integers
# into a 2D integer tensor of shape `(samples, maxlen)`
x_train = keras.utils.pad_sequences(x_train, maxlen=maxlen)
x_test = keras.utils.pad_sequences(x_test, maxlen=maxlen)


print(len(x_train))
```

```
800
```

```
from keras.models import Sequential
from keras.layers import Flatten, Dense

model = Sequential()
# We specify the maximum input length to our Embedding layer
# so we can later flatten the embedded inputs
model.add(Embedding(10000, 8, input_length=maxlen))
# After the Embedding layer,
# our activations have shape `(samples, maxlen, 8)`.

# We flatten the 3D tensor of embeddings
# into a 2D tensor of shape `(samples, maxlen * 8)`
model.add(Flatten())
```

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```
model.add(Dense(1, activation='sigmoid'))
model.compile(optimizer='rmsprop', loss='binary_crossentropy', metrics=['acc'])
model.summary()

history = model.fit(x_train, y_train,
                    epochs=10,
                    batch_size=32,
                    validation_split=0.2)
```

```
Model: "sequential_11"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 embedding_15 (Embedding)    (None, 150, 8)            80000

 flatten_11 (Flatten)        (None, 1200)              0

 dense_14 (Dense)            (None, 1)                 1201

=================================================================
Total params: 81,201
Trainable params: 81,201
Non-trainable params: 0
_________________________________________________________________
Epoch 1/10
20/20 [==============================] - 3s 107ms/step - loss: 0.6942 - acc: 0.4828 - val_loss: 0.6905 - val_acc: 0.5250
Epoch 2/10
20/20 [==============================] - 2s 99ms/step - loss: 0.6767 - acc: 0.7188 - val_loss: 0.6898 - val_acc: 0.5188
Epoch 3/10
20/20 [==============================] - 2s 84ms/step - loss: 0.6602 - acc: 0.8359 - val_loss: 0.6887 - val_acc: 0.5250
Epoch 4/10
20/20 [==============================] - 2s 123ms/step - loss: 0.6405 - acc: 0.8984 - val_loss: 0.6872 - val_acc: 0.5500
Epoch 5/10
20/20 [==============================] - 2s 96ms/step - loss: 0.6167 - acc: 0.9141 - val_loss: 0.6847 - val_acc: 0.5437
Epoch 6/10
20/20 [==============================] - 2s 77ms/step - loss: 0.5886 - acc: 0.9531 - val_loss: 0.6821 - val_acc: 0.5562
Epoch 7/10
20/20 [==============================] - 1s 54ms/step - loss: 0.5563 - acc: 0.9641 - val_loss: 0.6788 - val_acc: 0.5875
Epoch 8/10
20/20 [==============================] - 1s 44ms/step - loss: 0.5201 - acc: 0.9656 - val_loss: 0.6746 - val_acc: 0.5938
Epoch 9/10
20/20 [==============================] - 1s 33ms/step - loss: 0.4809 - acc: 0.9672 - val_loss: 0.6698 - val_acc: 0.6125
```

```
Epoch 10/10
20/20 [==============================] - 1s 21ms/step - loss: 0.4394 - acc: 0.9750 - val_loss: 0.6651 - val_acc: 0.6125
```

700 Samples

```
from keras.datasets import imdb
from keras import preprocessing

# Number of words to consider as features
max_features = 10000
# Cut texts after this number of words
# (among top max_features most common words)
maxlen = 150

# Load the data as lists of integers.
(x_train, y_train), (x_test, y_test) = imdb.load_data(num_words=max_features)

x_train = x_train[:700]
y_train = y_train[:700]

# This turns our lists of integers
# into a 2D integer tensor of shape `(samples, maxlen)`
x_train = keras.utils.pad_sequences(x_train, maxlen=maxlen)
x_test = keras.utils.pad_sequences(x_test, maxlen=maxlen)


from keras.models import Sequential
from keras.layers import Flatten, Dense

model = Sequential()
# We specify the maximum input length to our Embedding layer
# so we can later flatten the embedded inputs
model.add(Embedding(10000, 8, input_length=maxlen))
# After the Embedding layer,
# our activations have shape `(samples, maxlen, 8)`.

# We flatten the 3D tensor of embeddings
# into a 2D tensor of shape `(samples, maxlen * 8)`
model.add(Flatten())
```

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```
model.add(Dense(1, activation='sigmoid'))
model.compile(optimizer='rmsprop', loss='binary_crossentropy', metrics=['acc'])
model.summary()

history = model.fit(x_train, y_train,
                    epochs=10,
                    batch_size=32,
                    validation_split=0.2)
```

```
Model: "sequential_12"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 embedding_16 (Embedding)    (None, 150, 8)            80000

 flatten_12 (Flatten)        (None, 1200)              0

 dense_15 (Dense)            (None, 1)                 1201

=================================================================
Total params: 81,201
Trainable params: 81,201
Non-trainable params: 0
_________________________________________________________________
Epoch 1/10
18/18 [==============================] - 2s 102ms/step - loss: 0.6926 - acc: 0.5089 - val_loss: 0.6962 - val_acc: 0.5071
Epoch 2/10
18/18 [==============================] - 2s 111ms/step - loss: 0.6747 - acc: 0.7482 - val_loss: 0.6970 - val_acc: 0.5071
Epoch 3/10
18/18 [==============================] - 2s 87ms/step - loss: 0.6588 - acc: 0.8607 - val_loss: 0.6974 - val_acc: 0.5214
Epoch 4/10
18/18 [==============================] - 2s 85ms/step - loss: 0.6399 - acc: 0.9018 - val_loss: 0.6983 - val_acc: 0.4857
Epoch 5/10
18/18 [==============================] - 2s 114ms/step - loss: 0.6179 - acc: 0.9339 - val_loss: 0.6994 - val_acc: 0.4857
Epoch 6/10
18/18 [==============================] - 2s 129ms/step - loss: 0.5920 - acc: 0.9357 - val_loss: 0.7002 - val_acc: 0.4929
Epoch 7/10
18/18 [==============================] - 1s 64ms/step - loss: 0.5626 - acc: 0.9482 - val_loss: 0.7005 - val_acc: 0.5214
Epoch 8/10
18/18 [==============================] - 1s 57ms/step - loss: 0.5296 - acc: 0.9571 - val_loss: 0.7011 - val_acc: 0.5214
Epoch 9/10
18/18 [==============================] - 1s 67ms/step - loss: 0.4943 - acc: 0.9571 - val_loss: 0.7017 - val_acc: 0.5214
```

```
Epoch 10/10
18/18 [==============================] - 1s 51ms/step - loss: 0.4572 - acc: 0.9607 - val_loss: 0.7023 - val_acc: 0.5143
```

900 Samples

```
from keras.datasets import imdb
from keras import preprocessing

# Number of words to consider as features
max_features = 10000
# Cut texts after this number of words
# (among top max_features most common words)
maxlen = 150

# Load the data as lists of integers.
(x_train, y_train), (x_test, y_test) = imdb.load_data(num_words=max_features)

x_train = x_train[700:1600]
y_train = y_train[700:1600]

# This turns our lists of integers
# into a 2D integer tensor of shape `(samples, maxlen)`
x_train = keras.utils.pad_sequences(x_train, maxlen=maxlen)
x_test = keras.utils.pad_sequences(x_test, maxlen=maxlen)


from keras.models import Sequential
from keras.layers import Flatten, Dense

model = Sequential()
# We specify the maximum input length to our Embedding layer
# so we can later flatten the embedded inputs
model.add(Embedding(10000, 8, input_length=maxlen))
# After the Embedding layer,
# our activations have shape `(samples, maxlen, 8)`.

# We flatten the 3D tensor of embeddings
# into a 2D tensor of shape `(samples, maxlen * 8)`
model.add(Flatten())
```

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```
model.add(Dense(1, activation='sigmoid'))
model.compile(optimizer='rmsprop', loss='binary_crossentropy', metrics=['acc'])
model.summary()

history = model.fit(x_train, y_train,
                    epochs=10,
                    batch_size=32,
                    validation_split=0.2)
```

```
Model: "sequential_13"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 embedding_17 (Embedding)    (None, 150, 8)            80000

 flatten_13 (Flatten)        (None, 1200)              0

 dense_16 (Dense)            (None, 1)                 1201

=================================================================
Total params: 81,201
Trainable params: 81,201
Non-trainable params: 0
_________________________________________________________________
Epoch 1/10
23/23 [==============================] - 3s 105ms/step - loss: 0.6948 - acc: 0.4750 - val_loss: 0.6949 - val_acc: 0.4556
Epoch 2/10
23/23 [==============================] - 2s 98ms/step - loss: 0.6780 - acc: 0.7486 - val_loss: 0.6957 - val_acc: 0.4778
Epoch 3/10
23/23 [==============================] - 2s 76ms/step - loss: 0.6620 - acc: 0.8833 - val_loss: 0.6969 - val_acc: 0.4556
Epoch 4/10
23/23 [==============================] - 1s 59ms/step - loss: 0.6423 - acc: 0.9486 - val_loss: 0.6978 - val_acc: 0.4611
Epoch 5/10
23/23 [==============================] - 1s 66ms/step - loss: 0.6181 - acc: 0.9792 - val_loss: 0.6987 - val_acc: 0.4500
Epoch 6/10
23/23 [==============================] - 3s 125ms/step - loss: 0.5889 - acc: 0.9903 - val_loss: 0.6997 - val_acc: 0.4667
Epoch 7/10
23/23 [==============================] - 1s 51ms/step - loss: 0.5553 - acc: 0.9972 - val_loss: 0.7013 - val_acc: 0.4667
Epoch 8/10
23/23 [==============================] - 1s 64ms/step - loss: 0.5175 - acc: 0.9972 - val_loss: 0.7030 - val_acc: 0.4611
Epoch 9/10
23/23 [==============================] - 2s 63ms/step - loss: 0.4765 - acc: 0.9972 - val_loss: 0.7041 - val_acc: 0.4556
```

```
Epoch 10/10
23/23 [==============================] - 1s 62ms/step - loss: 0.4335 - acc: 0.9972 - val_loss: 0.7056 - val_acc: 0.4500
```

```
 After using both an embedding layer and a pretrained layer, I
determine that the plain embedding layer was the best approach
it the simplest method, but it produced the greatest accuracy
of 50.6% for the pretrained layer). After running some hypertu
layers, I was able to determine that the regular embedding lay
than the pretrained layer once the sample size reaches 800 sam
below 800 samples, it would be best to use a pretrained word e
layer.  ran the test originally with 1000 samples and pretrain
able to determine that the only was it the simplest method, bu
the Accuracy incrementally increased and decreased the number 
until I reached an accuracy slightly above the pretrained's ac
00%. The pretrained technique is best suited for small samples
once the sample size reaches 900, the best method to use is th
embedding layer.
```

After using both an embedding layer and a pretrained layer, I was able to determine that the plain embedding layer was the best approach. Not only was it the simplest method, but it produced the greatest accuracy (86.3% instead of 50.6% for the pretrained layer). After running some hypertuned embedding layers, I was able to determine that the regular embedding layer does better than the pretrained layer once the sample size reaches 800 samples. Anything below 800 samples, it would be best to use a pretrained word embedding layer. ran the test originally with 1000 samples and pretrained layer, I was able to determine that the only was it the simplest method, but it produced the Accuracy incrementally increased and decreased the number of samples until I reached an accuracy slightly above the pretrained's accuracy of 45.00%. The pretrained technique is best suited for small samples sizes, but once the sample size reaches 900, the best method to use is the regular embedding layer.

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