

# assignment5\_1

July 9, 2021

```
[1]: 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
/opt/conda/lib/python3.8/site-
packages/tensorflow/python/keras/datasets/imdb.py:159:
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])
/opt/conda/lib/python3.8/site-
packages/tensorflow/python/keras/datasets/imdb.py:160:
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:])
```

```
[2]: train_data[0]
```

```
[2]: [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]
```

```
[3]: train_labels[0]
```

```
[3]: 1
```

```
[4]: max([max(sequence) for sequence in train_data])
```

```
[4]: 9999
```

```
[5]: 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)
```

```
[6]: x_train[0]
```

```
[6]: array([0., 1., 1., ..., 0., 0., 0.])
```

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

```
[8]: 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'))

```

```

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

```

```

[10]: from keras import optimizers

model.compile(optimizer=optimizers.RMSprop(lr=0.001),
              loss='binary_crossentropy',
              metrics=['accuracy'])

```

```

[11]: from keras import losses
      from keras import metrics

model.compile(optimizer=optimizers.RMSprop(lr=0.001),
              loss=losses.binary_crossentropy,
              metrics=[metrics.binary_accuracy])

```

```

[12]: x_val = x_train[:10000]
      partial_x_train = x_train[10000:]
      y_val = y_train[:10000]
      partial_y_train = y_train[10000:]

```

```

[13]: 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 [=====] - 2s 54ms/step - loss: 0.5941 - acc: 0.7209 - val\_loss: 0.4155 - val\_acc: 0.8518

Epoch 2/20

30/30 [=====] - 0s 14ms/step - loss: 0.3391 - acc: 0.8947 - val\_loss: 0.3236 - val\_acc: 0.8749

Epoch 3/20

30/30 [=====] - 0s 11ms/step - loss: 0.2326 - acc: 0.9253 - val\_loss: 0.2833 - val\_acc: 0.8903

Epoch 4/20  
30/30 [=====] - 0s 12ms/step - loss: 0.1800 - acc: 0.9435 - val\_loss: 0.2907 - val\_acc: 0.8838

Epoch 5/20  
30/30 [=====] - 0s 12ms/step - loss: 0.1550 - acc: 0.9481 - val\_loss: 0.2767 - val\_acc: 0.8887

Epoch 6/20  
30/30 [=====] - 0s 12ms/step - loss: 0.1191 - acc: 0.9656 - val\_loss: 0.2869 - val\_acc: 0.8871

Epoch 7/20  
30/30 [=====] - 0s 13ms/step - loss: 0.0971 - acc: 0.9739 - val\_loss: 0.3039 - val\_acc: 0.8870

Epoch 8/20  
30/30 [=====] - 0s 13ms/step - loss: 0.0822 - acc: 0.9786 - val\_loss: 0.3566 - val\_acc: 0.8761

Epoch 9/20  
30/30 [=====] - 0s 13ms/step - loss: 0.0679 - acc: 0.9842 - val\_loss: 0.3555 - val\_acc: 0.8800

Epoch 10/20  
30/30 [=====] - 0s 12ms/step - loss: 0.0540 - acc: 0.9881 - val\_loss: 0.4079 - val\_acc: 0.8730

Epoch 11/20  
30/30 [=====] - 0s 11ms/step - loss: 0.0487 - acc: 0.9895 - val\_loss: 0.3845 - val\_acc: 0.8778

Epoch 12/20  
30/30 [=====] - 0s 12ms/step - loss: 0.0354 - acc: 0.9936 - val\_loss: 0.4256 - val\_acc: 0.8703

Epoch 13/20  
30/30 [=====] - 0s 12ms/step - loss: 0.0268 - acc: 0.9960 - val\_loss: 0.4459 - val\_acc: 0.8741

Epoch 14/20  
30/30 [=====] - 0s 17ms/step - loss: 0.0232 - acc: 0.9962 - val\_loss: 0.4869 - val\_acc: 0.8734

Epoch 15/20  
30/30 [=====] - 1s 30ms/step - loss: 0.0170 - acc: 0.9981 - val\_loss: 0.5634 - val\_acc: 0.8676

Epoch 16/20  
30/30 [=====] - 1s 21ms/step - loss: 0.0141 - acc: 0.9988 - val\_loss: 0.6041 - val\_acc: 0.8676

Epoch 17/20  
30/30 [=====] - 0s 14ms/step - loss: 0.0111 - acc: 0.9994 - val\_loss: 0.5862 - val\_acc: 0.8682

Epoch 18/20  
30/30 [=====] - 0s 12ms/step - loss: 0.0074 - acc: 0.9993 - val\_loss: 0.6256 - val\_acc: 0.8680

Epoch 19/20  
30/30 [=====] - 0s 12ms/step - loss: 0.0046 - acc: 0.9999 - val\_loss: 0.6767 - val\_acc: 0.8669



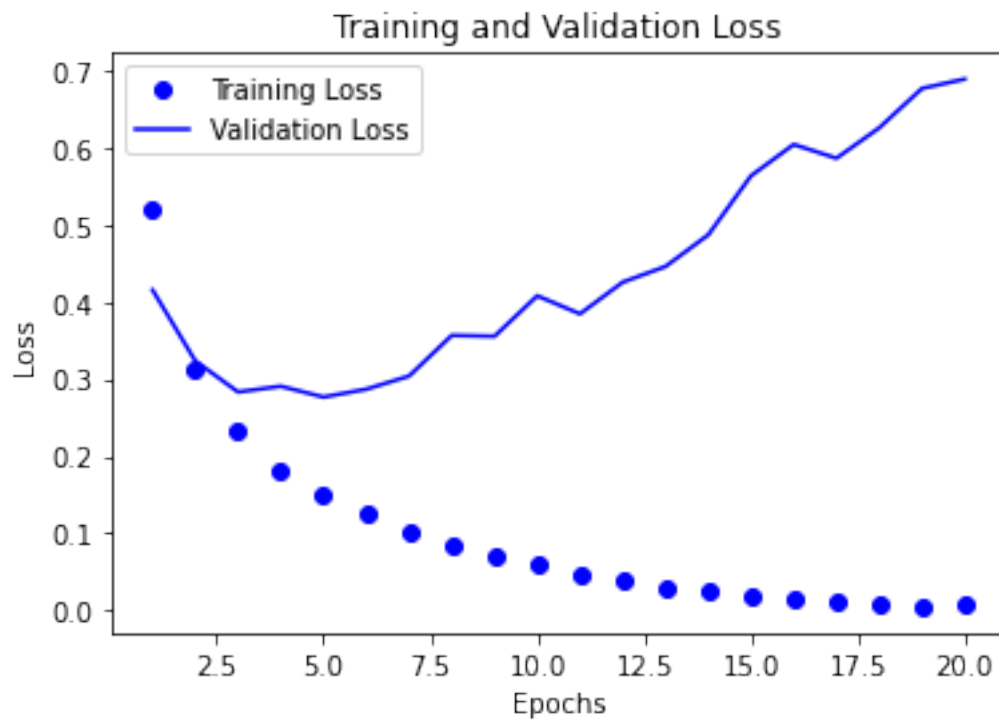
```
Epoch 20/20  
30/30 [=====] - 0s 12ms/step - loss: 0.0083 - acc:  
0.9989 - val_loss: 0.6888 - val_acc: 0.8667
```

```
[14]: history_dict = history.history  
      history_dict.keys()
```

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

```
[15]: 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(history_dict['acc']) + 1)
```

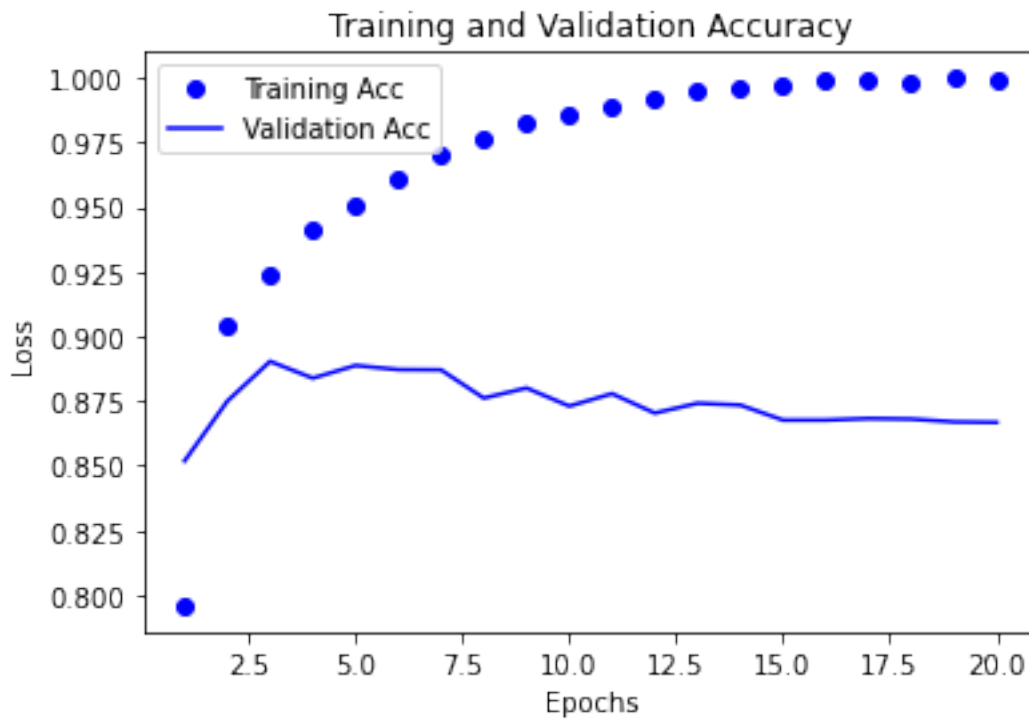
```
[16]: plt.plot(epochs, loss_values, 'bo', label = 'Training Loss')  
      plt.plot(epochs, val_loss_values, 'b', label = 'Validation Loss')  
      plt.title('Training and Validation Loss')  
      plt.xlabel('Epochs')  
      plt.ylabel('Loss')  
      plt.legend()  
  
      plt.show()
```



```
[17]: 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()
```



```
[18]: model2 = models.Sequential()
model2.add(layers.Dense(16, activation='relu', input_shape=(10000,)))
model2.add(layers.Dense(16, activation='relu'))
model2.add(layers.Dense(1, activation='sigmoid'))

model2.compile(optimizer='rmsprop',
               loss='binary_crossentropy',
               metrics=['accuracy'])
```

```
model2.fit(x_train, y_train, epochs=4, batch_size=512)
results = model2.evaluate(x_test, y_test)
```

```
Epoch 1/4
49/49 [=====] - 1s 10ms/step - loss: 0.5490 - accuracy:
0.7349
Epoch 2/4
49/49 [=====] - 0s 8ms/step - loss: 0.2651 - accuracy:
0.9085
Epoch 3/4
49/49 [=====] - 0s 8ms/step - loss: 0.1894 - accuracy:
0.9372
Epoch 4/4
49/49 [=====] - 0s 7ms/step - loss: 0.1600 - accuracy:
0.9464
782/782 [=====] - 2s 2ms/step - loss: 0.3010 -
accuracy: 0.8816
```

```
[19]: results
```

```
[19]: [0.3010491132736206, 0.8816400170326233]
```

```
[20]: model2.predict(x_test)
```

```
[20]: array([[0.2440716 ],
           [0.9999583 ],
           [0.9234549 ],
           ...,
           [0.1315352 ],
           [0.09187913],
           [0.7623006 ]], dtype=float32)
```

```
[67]: # 5.3
```

```
[75]: from keras.datasets import boston_housing

(train_data, train_targets), (test_data, test_targets) = boston_housing.
↳load_data()
```

```
[69]: train_data.shape
```

```
[69]: (404, 13)
```

```
[70]: test_data.shape
```

```
[70]: (102, 13)
```

```
[71]: mean = train_data.mean(axis=0)
train_data -= mean
std = train_data.std(axis=0)
train_data /= std
test_data -= mean
test_data /= std
```

```
[72]: def build_model():
    model = models.Sequential()
    model.add(layers.Dense(64, activation='relu',
                           input_shape=(train_data.shape[1],)))
    model.add(layers.Dense(64, activation='relu'))
    model.add(layers.Dense(1))
    model.compile(optimizer='rmsprop', loss='mse', metrics=['mae'])
    return model
```

```
[76]: k = 4
num_val_samples = len(train_data) // k
num_epochs = 100
all_scores = []

for i in range(k):
    print('processing fold #', i)
    val_data = train_data[i * num_val_samples: (i + 1) * num_val_samples]
    val_targets = train_targets[i * num_val_samples: (i + 1) * num_val_samples]

    partial_train_data = np.concatenate(
        [train_data[:i * num_val_samples],
         train_data[(i + 1) * num_val_samples:]],
        axis=0)
    partial_train_targets = np.concatenate(
        [train_targets[:i * num_val_samples],
         train_targets[(i + 1) * num_val_samples:]],
        axis=0)

    model = build_model()
    model.fit(partial_train_data, partial_train_targets,
              epochs=num_epochs, batch_size=1, verbose=0)
    val_mse, val_mae = model.evaluate(val_data, val_targets, verbose=0)
    all_scores.append(val_mse)
```

```
processing fold # 0
processing fold # 1
processing fold # 2
processing fold # 3
```

```
[77]: all_scores
```

```
[77]: [31.568052291870117, 14.436395645141602, 30.170917510986328, 24.42266082763672]
```

```
[78]: np.mean(all_scores)
```

```
[78]: 25.14950656890869
```

```
[ ]: num_epochs = 500
all_mae_histories = []
for i in range(k):
    print('processing fold #', i)
    val_data = train_data[i * num_val_samples: (i + 1) * num_val_samples]
    val_targets = train_targets[i * num_val_samples: (i + 1) * num_val_samples]

    partial_train_data = np.concatenate(
        [train_data[:i * num_val_samples],
         train_data[(i + 1) * num_val_samples:]],
        axis=0)
    partial_train_targets = np.concatenate(
        [train_targets[:i * num_val_samples],
         train_targets[(i + 1) * num_val_samples:]],
        axis=0)

    model = build_model()
    model.fit(partial_train_data, partial_train_targets,
              epochs=num_epochs, batch_size=1, verbose=0)
    history = model.fit(partial_train_data, partial_train_targets,
                       validation_data=(val_data, val_targets),
                       epochs=num_epochs, batch_size=1, verbose=0)
    mae_history = history.history['val_mean_absolute_error']
    all_mae_histories.append(mae_history)
```

processing fold # 0

```
[ ]: average_mae_history = [
    np.mean([x[i] for x in all_mae_histories]) for i in range(num_epochs)]
```

```
[ ]: plt.plot(range(1, len(average_mae_history) + 1), average_mae_history)
plt.xlabel('Epochs')
plt.ylabel('Validation MAE')
plt.show()
```

```
[83]: history.history
```

```
[83]: {'loss': [11.39948558807373,
12.008932113647461,
10.58810806274414,
11.0040864944458,
```

11.178390502929688,  
9.98036003112793,  
11.022878646850586,  
12.241138458251953,  
11.849650382995605,  
11.735089302062988,  
12.00673770904541,  
11.792015075683594,  
12.93335247039795,  
8.96514892578125,  
10.217604637145996,  
10.196910858154297,  
10.440271377563477,  
10.550606727600098,  
10.79206657409668,  
10.197373390197754,  
10.15755844116211,  
10.284110069274902,  
10.776142120361328,  
11.470969200134277,  
10.869176864624023,  
11.815011978149414,  
11.598451614379883,  
10.063990592956543,  
12.677311897277832,  
10.454682350158691,  
10.119773864746094,  
11.928876876831055,  
11.894856452941895,  
11.490793228149414,  
12.642419815063477,  
11.81715202331543,  
10.050021171569824,  
10.972596168518066,  
9.792290687561035,  
9.78904914855957,  
10.864483833312988,  
10.723670959472656,  
11.202280044555664,  
9.208810806274414,  
12.750126838684082,  
10.661993980407715,  
10.576739311218262,  
12.322608947753906,  
12.888575553894043,  
11.790568351745605,  
10.910340309143066,

9.564969062805176,  
10.686418533325195,  
10.355598449707031,  
11.098249435424805,  
11.356355667114258,  
10.313985824584961,  
11.214044570922852,  
11.362137794494629,  
11.864688873291016,  
10.941230773925781,  
10.302278518676758,  
10.540679931640625,  
10.986284255981445,  
9.01644229888916,  
8.977224349975586,  
10.060026168823242,  
9.410164833068848,  
11.79732608795166,  
9.971171379089355,  
11.464973449707031,  
10.845575332641602,  
11.464025497436523,  
9.293532371520996,  
10.583074569702148,  
9.952507972717285,  
11.429290771484375,  
10.20578670501709,  
11.724905014038086,  
11.153421401977539,  
10.876428604125977,  
9.41261100769043,  
11.34691047668457,  
11.101140022277832,  
11.138019561767578,  
11.786322593688965,  
10.98471736907959,  
11.931448936462402,  
11.42587947845459,  
10.378959655761719,  
10.133951187133789,  
10.223090171813965,  
10.925850868225098,  
9.53038215637207,  
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9.762075424194336,  
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9.540603637695312,

10.656081199645996,  
9.545211791992188,  
10.872385025024414,  
10.13565444946289,  
9.580592155456543,  
10.255404472351074,  
8.612444877624512,  
13.484648704528809,  
10.144928932189941,  
10.14675521850586,  
10.266749382019043,  
10.043471336364746,  
9.033914566040039,  
9.02224063873291,  
8.512534141540527,  
11.242334365844727,  
10.684775352478027,  
10.468457221984863,  
9.118135452270508,  
10.398465156555176,  
9.6463623046875,  
10.087084770202637,  
9.680874824523926,  
9.112817764282227,  
10.141046524047852,  
9.466076850891113,  
10.467464447021484,  
11.147711753845215,  
10.211649894714355,  
9.49593734741211,  
8.86913776397705,  
10.992243766784668,  
9.929621696472168,  
10.248699188232422,  
9.685626029968262,  
9.357209205627441,  
9.149869918823242,  
11.443891525268555,  
9.26005744934082,  
8.69773006439209,  
9.74946403503418,  
9.19704532623291,  
9.453234672546387,  
10.472323417663574,  
8.921346664428711,  
10.681050300598145,  
10.096004486083984,



8.410985946655273,  
10.635595321655273,  
10.603652954101562,  
8.439887046813965,  
9.858128547668457,  
10.965550422668457,  
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9.645795822143555,  
9.264670372009277,  
8.92983627319336,  
8.400875091552734,  
8.463065147399902,  
10.384138107299805,  
9.574996948242188,  
8.609159469604492,  
9.355161666870117,  
10.57398796081543,  
9.079705238342285,  
10.626611709594727,  
7.776620388031006,  
10.602359771728516,  
10.024002075195312,  
9.425922393798828,  
10.500509262084961,  
8.36012077331543,  
9.969547271728516,  
10.020201683044434,  
10.195088386535645,  
9.279153823852539,  
10.56462287902832,  
10.528364181518555,  
10.057767868041992,  
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9.556233406066895,  
8.123760223388672,  
9.797262191772461,  
8.861455917358398,  
8.389126777648926,  
9.643692970275879,  
8.007344245910645,  
10.20874309539795,  
9.22463607788086,  
9.436273574829102,  
9.507720947265625,  
9.745932579040527,  
10.43556022644043,  
9.802897453308105,

10.725382804870605,  
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