

Course1-week2

June 20, 2020

```
[30]: import pandas as pd
import numpy as np
import tensorflow as tf
from tensorflow import keras
import matplotlib.pyplot as plt
```

```
[2]: fashion_mnist = keras.datasets.fashion_mnist
(train_images, train_labels), (test_images, test_labels) = fashion_mnist.
↳load_data()
```

Downloading data from <https://storage.googleapis.com/tensorflow/tf-keras-datasets/train-labels-idx1-ubyte.gz>

32768/29515 [=====] - 0s 1us/step

Downloading data from <https://storage.googleapis.com/tensorflow/tf-keras-datasets/train-images-idx3-ubyte.gz>

26427392/26421880 [=====] - 78s 3us/step

Downloading data from <https://storage.googleapis.com/tensorflow/tf-keras-datasets/t10k-labels-idx1-ubyte.gz>

8192/5148 [=====] - 0s 0us/step

Downloading data from <https://storage.googleapis.com/tensorflow/tf-keras-datasets/t10k-images-idx3-ubyte.gz>

4423680/4422102 [=====] - 8s 2us/step

```
[4]: print(train_images.shape)
```

(60000, 28, 28)

```
[6]: train_images = train_images / 255.0
test_images = test_images / 255.0
```

```
[8]: from tensorflow.keras import layers
from tensorflow.keras.models import load_model
```

```
[9]: model = keras.Sequential([
    layers.Flatten(),
    layers.Dense(256, activation = 'relu'),
    layers.Dense(10, activation = 'softmax')
])
```

```
[16]: model.compile(optimizer = 'adam', loss = 'sparse_categorical_crossentropy',  
    ↪ metrics = ['accuracy'])
```

```
[17]: history = model.fit(train_images, train_labels, epochs = 100, verbose = 1)
```

```
Epoch 1/100  
1875/1875 [=====] - 4s 2ms/step - loss: 0.4852 -  
accuracy: 0.8271  
Epoch 2/100  
1875/1875 [=====] - 4s 2ms/step - loss: 0.3646 -  
accuracy: 0.8678  
Epoch 3/100  
1875/1875 [=====] - 5s 3ms/step - loss: 0.3275 -  
accuracy: 0.8806  
Epoch 4/100  
1875/1875 [=====] - 3s 2ms/step - loss: 0.3022 -  
accuracy: 0.8899  
Epoch 5/100  
1875/1875 [=====] - 3s 2ms/step - loss: 0.2846 -  
accuracy: 0.8942  
Epoch 6/100  
1875/1875 [=====] - 3s 2ms/step - loss: 0.2699 -  
accuracy: 0.8992  
Epoch 7/100  
1875/1875 [=====] - 3s 2ms/step - loss: 0.2582 -  
accuracy: 0.9026  
Epoch 8/100  
1875/1875 [=====] - 3s 2ms/step - loss: 0.2462 -  
accuracy: 0.9068  
Epoch 9/100  
1875/1875 [=====] - 3s 2ms/step - loss: 0.2348 -  
accuracy: 0.9114  
Epoch 10/100  
1875/1875 [=====] - 3s 2ms/step - loss: 0.2275 -  
accuracy: 0.9150  
Epoch 11/100  
1875/1875 [=====] - 3s 2ms/step - loss: 0.2186 -  
accuracy: 0.9166  
Epoch 12/100  
1875/1875 [=====] - 3s 2ms/step - loss: 0.2127 -  
accuracy: 0.9200  
Epoch 13/100  
1875/1875 [=====] - 6s 3ms/step - loss: 0.2054 -  
accuracy: 0.9220  
Epoch 14/100  
1875/1875 [=====] - 5s 3ms/step - loss: 0.1971 -  
accuracy: 0.9268
```

Epoch 15/100
1875/1875 [=====] - 5s 3ms/step - loss: 0.1902 -
accuracy: 0.9287
Epoch 16/100
1875/1875 [=====] - 5s 2ms/step - loss: 0.1859 -
accuracy: 0.9298
Epoch 17/100
1875/1875 [=====] - 6s 3ms/step - loss: 0.1798 -
accuracy: 0.9325
Epoch 18/100
1875/1875 [=====] - 4s 2ms/step - loss: 0.1745 -
accuracy: 0.9339
Epoch 19/100
1875/1875 [=====] - 4s 2ms/step - loss: 0.1702 -
accuracy: 0.9362
Epoch 20/100
1875/1875 [=====] - 5s 3ms/step - loss: 0.1638 -
accuracy: 0.9367
Epoch 21/100
1875/1875 [=====] - 6s 3ms/step - loss: 0.1577 -
accuracy: 0.9412
Epoch 22/100
1875/1875 [=====] - 5s 3ms/step - loss: 0.1556 -
accuracy: 0.9411
Epoch 23/100
1875/1875 [=====] - 4s 2ms/step - loss: 0.1499 -
accuracy: 0.9442
Epoch 24/100
1875/1875 [=====] - 5s 2ms/step - loss: 0.1477 -
accuracy: 0.9439
Epoch 25/100
1875/1875 [=====] - 5s 3ms/step - loss: 0.1419 -
accuracy: 0.9454
Epoch 26/100
1875/1875 [=====] - 6s 3ms/step - loss: 0.1377 -
accuracy: 0.9481
Epoch 27/100
1875/1875 [=====] - 5s 2ms/step - loss: 0.1362 -
accuracy: 0.9487
Epoch 28/100
1875/1875 [=====] - 5s 3ms/step - loss: 0.1330 -
accuracy: 0.9492
Epoch 29/100
1875/1875 [=====] - 5s 3ms/step - loss: 0.1298 -
accuracy: 0.9507
Epoch 30/100
1875/1875 [=====] - 5s 3ms/step - loss: 0.1266 -
accuracy: 0.9522

Epoch 31/100
1875/1875 [=====] - 6s 3ms/step - loss: 0.1219 -
accuracy: 0.9535

Epoch 32/100
1875/1875 [=====] - 5s 2ms/step - loss: 0.1195 -
accuracy: 0.9542

Epoch 33/100
1875/1875 [=====] - 5s 3ms/step - loss: 0.1171 -
accuracy: 0.9558

Epoch 34/100
1875/1875 [=====] - 6s 3ms/step - loss: 0.1155 -
accuracy: 0.9566

Epoch 35/100
1875/1875 [=====] - 6s 3ms/step - loss: 0.1145 -
accuracy: 0.9558

Epoch 36/100
1875/1875 [=====] - 6s 3ms/step - loss: 0.1110 -
accuracy: 0.9579

Epoch 37/100
1875/1875 [=====] - 5s 3ms/step - loss: 0.1100 -
accuracy: 0.9585

Epoch 38/100
1875/1875 [=====] - 6s 3ms/step - loss: 0.1062 -
accuracy: 0.9599

Epoch 39/100
1875/1875 [=====] - 5s 2ms/step - loss: 0.1020 -
accuracy: 0.9623

Epoch 40/100
1875/1875 [=====] - 5s 3ms/step - loss: 0.1032 -
accuracy: 0.9611

Epoch 41/100
1875/1875 [=====] - 7s 4ms/step - loss: 0.1001 -
accuracy: 0.9622

Epoch 42/100
1875/1875 [=====] - 7s 4ms/step - loss: 0.0950 -
accuracy: 0.9640

Epoch 43/100
1875/1875 [=====] - 6s 3ms/step - loss: 0.0969 -
accuracy: 0.9636

Epoch 44/100
1875/1875 [=====] - 4s 2ms/step - loss: 0.0931 -
accuracy: 0.9647

Epoch 45/100
1875/1875 [=====] - 4s 2ms/step - loss: 0.0935 -
accuracy: 0.9644

Epoch 46/100
1875/1875 [=====] - 4s 2ms/step - loss: 0.0916 -
accuracy: 0.9656

Epoch 47/100
1875/1875 [=====] - 6s 3ms/step - loss: 0.0878 -
accuracy: 0.9668

Epoch 48/100
1875/1875 [=====] - 6s 3ms/step - loss: 0.0865 -
accuracy: 0.9671

Epoch 49/100
1875/1875 [=====] - ETA: 0s - loss: 0.0863 - accuracy:
0.96 - 6s 3ms/step - loss: 0.0863 - accuracy: 0.9675

Epoch 50/100
1875/1875 [=====] - 6s 3ms/step - loss: 0.0838 -
accuracy: 0.9683

Epoch 51/100
1875/1875 [=====] - 6s 3ms/step - loss: 0.0836 -
accuracy: 0.9690

Epoch 52/100
1875/1875 [=====] - 7s 3ms/step - loss: 0.0820 -
accuracy: 0.9687

Epoch 53/100
1875/1875 [=====] - 6s 3ms/step - loss: 0.0802 -
accuracy: 0.9699

Epoch 54/100
1875/1875 [=====] - 6s 3ms/step - loss: 0.0805 -
accuracy: 0.9702

Epoch 55/100
1875/1875 [=====] - 6s 3ms/step - loss: 0.0762 -
accuracy: 0.9715

Epoch 56/100
1875/1875 [=====] - 7s 4ms/step - loss: 0.0758 -
accuracy: 0.9715

Epoch 57/100
1875/1875 [=====] - 5s 2ms/step - loss: 0.0775 -
accuracy: 0.9716

Epoch 58/100
1875/1875 [=====] - 5s 3ms/step - loss: 0.0727 -
accuracy: 0.9726

Epoch 59/100
1875/1875 [=====] - 4s 2ms/step - loss: 0.0703 -
accuracy: 0.9734

Epoch 60/100
1875/1875 [=====] - 6s 3ms/step - loss: 0.0747 -
accuracy: 0.9728

Epoch 61/100
1875/1875 [=====] - 4s 2ms/step - loss: 0.0718 -
accuracy: 0.9731

Epoch 62/100
1875/1875 [=====] - 6s 3ms/step - loss: 0.0684 -
accuracy: 0.9743

Epoch 63/100
1875/1875 [=====] - 6s 3ms/step - loss: 0.0667 -
accuracy: 0.9754

Epoch 64/100
1875/1875 [=====] - 6s 3ms/step - loss: 0.0683 -
accuracy: 0.9738

Epoch 65/100
1875/1875 [=====] - 6s 3ms/step - loss: 0.0663 -
accuracy: 0.9753

Epoch 66/100
1875/1875 [=====] - 4s 2ms/step - loss: 0.0630 -
accuracy: 0.9764

Epoch 67/100
1875/1875 [=====] - 4s 2ms/step - loss: 0.0622 -
accuracy: 0.9760

Epoch 68/100
1875/1875 [=====] - 8s 4ms/step - loss: 0.0635 -
accuracy: 0.9761

Epoch 69/100
1875/1875 [=====] - 4s 2ms/step - loss: 0.0625 -
accuracy: 0.9765

Epoch 70/100
1875/1875 [=====] - 5s 3ms/step - loss: 0.0618 -
accuracy: 0.9776

Epoch 71/100
1875/1875 [=====] - 5s 3ms/step - loss: 0.0593 -
accuracy: 0.9780

Epoch 72/100
1875/1875 [=====] - 6s 3ms/step - loss: 0.0602 -
accuracy: 0.9779

Epoch 73/100
1875/1875 [=====] - 5s 3ms/step - loss: 0.0576 -
accuracy: 0.9783

Epoch 74/100
1875/1875 [=====] - 5s 3ms/step - loss: 0.0594 -
accuracy: 0.9782

Epoch 75/100
1875/1875 [=====] - 6s 3ms/step - loss: 0.0565 -
accuracy: 0.9795

Epoch 76/100
1875/1875 [=====] - 6s 3ms/step - loss: 0.0571 -
accuracy: 0.9784

Epoch 77/100
1875/1875 [=====] - 7s 4ms/step - loss: 0.0577 -
accuracy: 0.9782

Epoch 78/100
1875/1875 [=====] - 7s 4ms/step - loss: 0.0527 -
accuracy: 0.9806

Epoch 79/100
1875/1875 [=====] - 4s 2ms/step - loss: 0.0549 -
accuracy: 0.9798
Epoch 80/100
1875/1875 [=====] - 4s 2ms/step - loss: 0.0560 -
accuracy: 0.9794
Epoch 81/100
1875/1875 [=====] - 4s 2ms/step - loss: 0.0520 -
accuracy: 0.9804
Epoch 82/100
1875/1875 [=====] - 4s 2ms/step - loss: 0.0538 -
accuracy: 0.9805
Epoch 83/100
1875/1875 [=====] - 4s 2ms/step - loss: 0.0521 -
accuracy: 0.9803
Epoch 84/100
1875/1875 [=====] - 5s 3ms/step - loss: 0.0518 -
accuracy: 0.9807
Epoch 85/100
1875/1875 [=====] - 6s 3ms/step - loss: 0.0503 -
accuracy: 0.9813
Epoch 86/100
1875/1875 [=====] - 5s 3ms/step - loss: 0.0505 -
accuracy: 0.9811
Epoch 87/100
1875/1875 [=====] - 6s 3ms/step - loss: 0.0478 -
accuracy: 0.9819
Epoch 88/100
1875/1875 [=====] - 6s 3ms/step - loss: 0.0477 -
accuracy: 0.9825
Epoch 89/100
1875/1875 [=====] - 5s 3ms/step - loss: 0.0483 -
accuracy: 0.9824
Epoch 90/100
1875/1875 [=====] - 5s 3ms/step - loss: 0.0502 -
accuracy: 0.9812
Epoch 91/100
1875/1875 [=====] - 5s 3ms/step - loss: 0.0468 -
accuracy: 0.9833
Epoch 92/100
1875/1875 [=====] - 5s 3ms/step - loss: 0.0461 -
accuracy: 0.9831
Epoch 93/100
1875/1875 [=====] - 6s 3ms/step - loss: 0.0465 -
accuracy: 0.9823
Epoch 94/100
1875/1875 [=====] - 6s 3ms/step - loss: 0.0436 -
accuracy: 0.9845

```
Epoch 95/100
1875/1875 [=====] - 6s 3ms/step - loss: 0.0457 -
accuracy: 0.9836
Epoch 96/100
1875/1875 [=====] - 5s 3ms/step - loss: 0.0460 -
accuracy: 0.9828
Epoch 97/100
1875/1875 [=====] - 6s 3ms/step - loss: 0.0448 -
accuracy: 0.9835
Epoch 98/100
1875/1875 [=====] - 6s 3ms/step - loss: 0.0436 -
accuracy: 0.9846
Epoch 99/100
1875/1875 [=====] - 6s 3ms/step - loss: 0.0431 -
accuracy: 0.9843
Epoch 100/100
1875/1875 [=====] - 6s 3ms/step - loss: 0.0466 -
accuracy: 0.9829
```

```
[18]: model.save("clothing_model.h5")
      print("Saved Model to Disk")
```

Saved Model to Disk

```
[19]: model = load_model("clothing_model.h5")
      y_hat = model.predict(test_images)
```

```
[35]: model.evaluate(test_images, test_labels)
```

```
313/313 [=====] - 0s 2ms/step - loss: 0.8466 -
accuracy: 0.8834
```

```
[35]: [0.8465911149978638, 0.883400022983551]
```

```
[33]: plt.figure(figsize=(10,10))
      plt.style.use('dark_background')
      plt.plot(history.history['accuracy'])
      # plt.plot(history.history['val_accuracy'])
      plt.title('Model Accuracy')
      plt.ylabel('Accuracy')
      plt.xlabel('Epoch')
      plt.legend(['Training', 'Testing'])
      plt.tight_layout()
      plt.show()
```

<IPython.core.display.Javascript object>

<IPython.core.display.HTML object>


```
[34]: plt.figure(figsize=(10,10))
plt.style.use('dark_background')
plt.plot(history.history['loss'])
# plt.plot(history.history['val_loss'])
plt.title('Model Loss')
plt.ylabel('Loss')
plt.xlabel('Epoch')
plt.legend(['Training', 'Testing'])
plt.show()
```

<IPython.core.display.Javascript object>

<IPython.core.display.HTML object>

```
[ ]:
```