assignment02

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1 Implement Convolutional Neural Network on Fashion MNIST Dataset

[ ]:
```
import tensorflow as tp
from keras.datasets import fashion_mnist
```

[ ]:
```
(x_train, y_train),(x_test, y_test) = fashion_mnist.load_data()
```

```
Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-
datasets/train-labels-idx1-ubyte.gz
29515/29515 [==============================] - 0s 0us/step
Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-
datasets/train-images-idx3-ubyte.gz
26421880/26421880 [==============================] - 0s 0us/step
Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-
datasets/t10k-labels-idx1-ubyte.gz
5148/5148 [==============================] - 0s 0us/step
Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-
datasets/t10k-images-idx3-ubyte.gz
4422102/4422102 [==============================] - 0s 0us/step
```

[ ]:
```
print("x_train shape", x_train.shape)
print("y_train shape", y_train.shape)
print("x_test shape", x_test.shape)
print("y_test shape", y_test.shape)
```

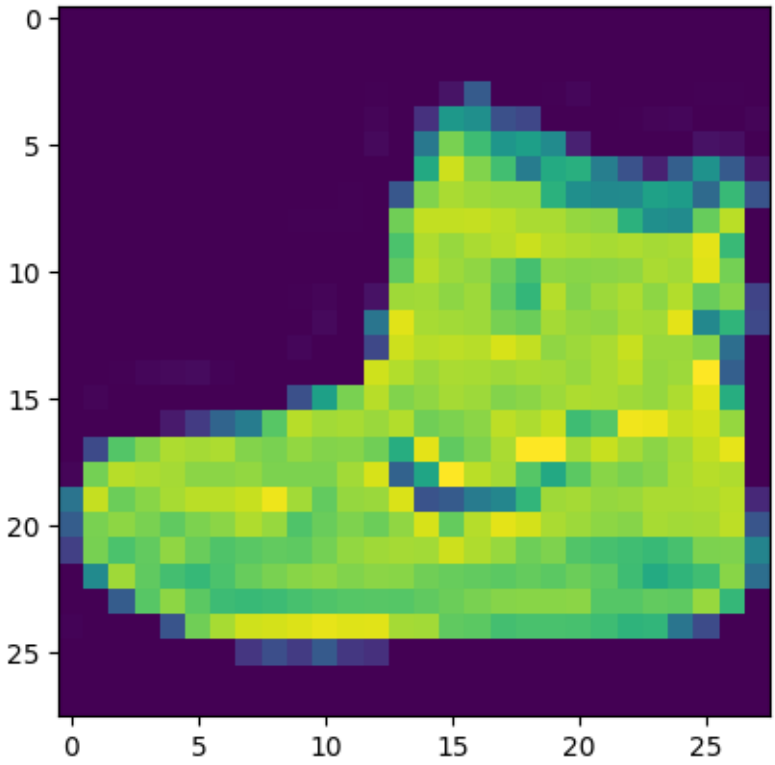
```
x_train shape (60000, 28, 28)
y_train shape (60000,)
x_test shape (10000, 28, 28)
y_test shape (10000,)
```

[ ]:
```
import numpy as np
import matplotlib.pyplot as plt
```

[ ]:
```
plt.imshow(x_train[0])
print(x_train[0])
```

```
[[  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
    0   0   0   0   0   0   0   0   0   0]
 [  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
    0   0   0   0   0   0   0   0   0   0]
 [  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
    0   0   0   0   0   0   0   0   0   0]
 [  0   0   0   0   0   0   0   0   0   0   0   0   1   0   0  13  73   0
    0   1   4   0   0   0   0   1   1   0]
 [  0   0   0   0   0   0   0   0   0   0   0   0   3   0  36 136 127  62
   54   0   0   0   1   3   4   0   0   3]
 [  0   0   0   0   0   0   0   0   0   0   0   0   6   0 102 204 176 134
  144 123  23   0   0   0   0  12  10   0]
 [  0   0   0   0   0   0   0   0   0   0   0   0   0   0 155 236 207 178
  107 156 161 109  64  23  77 130  72  15]
 [  0   0   0   0   0   0   0   0   0   0   0   1   0  69 207 223 218 216
  216 163 127 121 122 146 141  88 172  66]
 [  0   0   0   0   0   0   0   0   0   1   1   1   0 200 232 232 233 229
  223 223 215 213 164 127 123 196 229   0]
 [  0   0   0   0   0   0   0   0   0   0   0   0   0 183 225 216 223 228
  235 227 224 222 224 221 223 245 173   0]
 [  0   0   0   0   0   0   0   0   0   0   0   0   0 193 228 218 213 198
  180 212 210 211 213 223 220 243 202   0]
 [  0   0   0   0   0   0   0   0   0   1   3   0  12 219 220 212 218 192
  169 227 208 218 224 212 226 197 209  52]
 [  0   0   0   0   0   0   0   0   0   0   6   0  99 244 222 220 218 203
  198 221 215 213 222 220 245 119 167  56]
 [  0   0   0   0   0   0   0   0   0   4   0   0  55 236 228 230 228 240
  232 213 218 223 234 217 217 209  92   0]
 [  0   0   1   4   6   7   2   0   0   0   0   0 237 226 217 223 222 219
  222 221 216 223 229 215 218 255  77   0]
 [  0   3   0   0   0   0   0   0   0  62 145 204 228 207 213 221 218 208
  211 218 224 223 219 215 224 244 159   0]
 [  0   0   0   0  18  44  82 107 189 228 220 222 217 226 200 205 211 230
  224 234 176 188 250 248 233 238 215   0]
 [  0  57 187 208 224 221 224 208 204 214 208 209 200 159 245 193 206 223
  255 255 221 234 221 211 220 232 246   0]
 [  3 202 228 224 221 211 211 214 205 205 205 220 240  80 150 255 229 221
  188 154 191 210 204 209 222 228 225   0]
 [ 98 233 198 210 222 229 229 234 249 220 194 215 217 241  65  73 106 117
  168 219 221 215 217 223 223 224 229  29]
 [ 75 204 212 204 193 205 211 225 216 185 197 206 198 213 240 195 227 245
  239 223 218 212 209 222 220 221 230  67]
 [ 48 203 183 194 213 197 185 190 194 192 202 214 219 221 220 236 225 216
  199 206 186 181 177 172 181 205 206 115]
```

```
[  0 122 219 193 179 171 183 196 204 210 213 207 211 210 200 196 194 191
 195 191 198 192 176 156 167 177 210  92]
[  0   0  74 189 212 191 175 172 175 181 185 188 189 188 193 198 204 209
 210 210 211 188 188 194 192 216 170   0]
[  2   0   0   0  66 200 222 237 239 242 246 243 244 221 220 193 191 179
 182 182 181 176 166 168  99  58   0   0]
[  0   0   0   0   0   0   0  40  61  44  72  41  35   0   0   0   0   0
   0   0   0   0   0   0   0   0   0   0]
[  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
   0   0   0   0   0   0   0   0   0   0]
[  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
   0   0   0   0   0   0   0   0   0   0]]
```



[ ]:
```
print(set(y_train))
```

```
{0, 1, 2, 3, 4, 5, 6, 7, 8, 9}
```

[ ]:
```
from keras.utils import to_categorical
y_train_encoded = to_categorical(y_train)
y_test_encoded = to_categorical(y_test)
print(y_train[5],y_train_encoded[5])
print(y_train[0],y_train_encoded[0])
```

```
2 [0. 0. 1. 0. 0. 0. 0. 0. 0. 0.]
9 [0. 0. 0. 0. 0. 0. 0. 0. 0. 1.]
```

[ ]:
```
print("y_train encoded shape ", y_train_encoded.shape)
print("y_test encoded shape ", y_test_encoded.shape)
```

```
y_train encoded shape  (60000, 10)
y_test encoded shape  (10000, 10)
```

#Preprocessing

[ ]:
```
x_train_reshaped = np.reshape(x_train, (60000, 784))
x_test_reshaped = np.reshape(x_test, (10000, 784))
print(x_train_reshaped.shape)
print(x_test_reshaped.shape)
```

```
(60000, 784)
(10000, 784)
```

[ ]:
```
# display pixel value
print(set(x_train_reshaped[0]))
```

```
{0, 1, 2, 3, 4, 6, 7, 10, 12, 13, 15, 18, 23, 29, 35, 36, 40, 41, 44, 48, 52,
54, 55, 56, 57, 58, 61, 62, 64, 65, 66, 67, 69, 72, 73, 74, 75, 77, 80, 82, 88,
92, 98, 99, 102, 106, 107, 109, 115, 117, 119, 121, 122, 123, 127, 130, 134,
136, 141, 144, 145, 146, 150, 154, 155, 156, 159, 161, 163, 164, 166, 167, 168,
169, 170, 171, 172, 173, 175, 176, 177, 178, 179, 180, 181, 182, 183, 185, 186,
187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 202, 203,
204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219,
220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 232, 233, 234, 235, 236,
237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 248, 249, 250, 255}
```

[ ]:
```
# Data normalization
import math
x_mean = np.mean(x_train_reshaped)
x_std = np.std(x_train_reshaped)
epsilon = pow(math.e,-10)
```

[ ]:
```
x_train_norm=(x_train_reshaped-x_mean)/(x_std+epsilon)
x_test_norm=(x_test_reshaped-x_mean)/(x_std+epsilon)
```

#CNN MODEL

[ ]:
```
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Reshape, Conv2D, MaxPooling2D,␣
↪Flatten
```

[ ]:
```
model = Sequential()
model.add(Reshape((28,28,1), input_shape=(784,)))
```

```
model.add(Conv2D(128, kernel_size=(3, 3), activation='relu'))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Conv2D(128, activation='relu'))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Flatten())
model.add(Dense(128, activation='relu'))
model.add(Dense(10, activation='softmax'))
```

[ ]:
```
#compiling model
model.
  ↪compile(optimizer='sgd',loss='categorical_crossentropy',metrics=['accuracy'])
#Training the model
model.fit(x_train_norm , y_train_encoded,epochs=3)
```

```
Epoch 1/3
1875/1875 [==============================] - 192s 102ms/step - loss: 0.6678 -
accuracy: 0.7645
Epoch 2/3
1875/1875 [==============================] - 191s 102ms/step - loss: 0.4227 -
accuracy: 0.8464
Epoch 3/3
1875/1875 [==============================] - 187s 100ms/step - loss: 0.3680 -
accuracy: 0.8669
```

[ ]:
```
<keras.src.callbacks.History at 0x78550be1a590>
```

[ ]:
```
#Evaluating the model
loss,accuracy=model.evaluate(x_test_norm,y_test_encoded)
print('Testset Accuracy=',accuracy*100)
```

[ ]:
```
pred = model.predict([x_test_norm])
pred[2]
```

[ ]:
```
plt.imshow(x_test[2],cmap='binary')
```