Here are the general steps to perform Convolutional Neural Network (CNN) on the MNIST Fashion dataset:

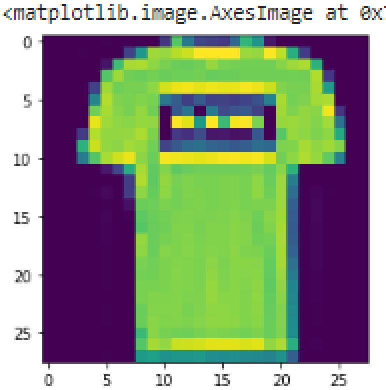
- Import the necessary libraries, including TensorFlow, Keras, NumPy, and Matplotlib.
- Load the dataset using Keras' built-in function, keras.datasets.fashion_mnist.load_data(). This will provide the training and testing sets, which will be used to train and evaluate the CNN.
- Preprocess the data by normalizing the pixel values between 0 and 1, and reshaping the images to be of size (28, 28, 1) for compatibility with the CNN.
- Define the CNN architecture, including the number and size of filters, activation functions, and pooling layers. This can vary based on the specific problem being addressed.
- Compile the model by specifying the loss function, optimizer, and evaluation metrics. Common choices include categorical cross-entropy, Adam optimizer, and accuracy metric.
- Train the CNN on the training set using the fit() function, specifying the number of epochs and batch size.
- Evaluate the performance of the model on the testing set using the evaluate() function. This will provide metrics such as accuracy and loss on the test set.
- Use the trained model to make predictions on new images, if desired, using the predict() function.

Source Code with Output-

```
import tensorflow as tf
import matplotlib.pyplot as plt
from tensorflow import keras
import numpy as np

(x_train, y_train), (x_test, y_test) = keras.datasets.fashion_mnist.load_data()

# There are 10 image classes in this dataset and each class has a mapping corresponding to the following labels:

#0 T-shirt/top
#1 Trouser
#2 pullover
#3 Dress
#4 Coat
#5 sandals
```

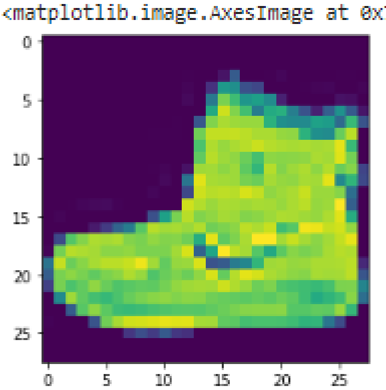
```
#6 shirt
#7 sneaker
#8 bag
#9 ankle boot
plt.imshow(x_train[1])
```

```
<matplotlib.image.AxesImage at 0x7f85874f3a00>
```



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

```
<matplotlib.image.AxesImage at 0x7f8584b93d00>
```



```
# Next, we will preprocess the data by scaling the pixel values to be between 0 and 1, and then reshaping the images to be 28x28 pixels.

x_train = x_train.astype('float32') / 255.0
x_test = x_test.astype('float32') / 255.0

x_train = x_train.reshape(-1, 28, 28, 1)
x_test = x_test.reshape(-1, 28, 28, 1)

# 28, 28 comes from width, height, 1 comes from the number of channels
# -1 means that the length in that dimension is inferred.
# This is done based on the constraint that the number of elements in an ndarray or Tensor when reshaped must remain the same.
```

```
# each image is a row vector (784 elements) and there are lots of such rows (let it be n, so there are 784n elements). So TensorFlow can infer that -1 is n.
# converting the training_images array to 4 dimensional array with sizes 60000, 28, 28, 1 for 0th to 3rd dimension.
x_train.shape
(60000, 28, 28)
x_test.shape
(10000, 28, 28, 1)
y_train.shape
(60000,)
y_test.shape
(10000,)
# We will use a convolutional neural network (CNN) to classify the fashion items.
# The CNN will consist of multiple convolutional layers followed by max pooling,
# dropout, and dense layers. Here is the code for the model:
model = keras.Sequential([
  keras.layers.Conv2D(32, (3,3), activation='relu', input_shape=(28,28,1)),
  # 32 filters (default), randomly initialized
  # 3*3 is Size of Filter
  # 28,28,1 size of Input Image
  # No zero-padding: every output 2 pixels less in every dimension
  # in Paramter shwon 320 is value of weights: (3x3 filter weights + 32 bias) * 32 filters
  # 32*3*3=288(Total)+32(bias)= 320
  keras.layers.MaxPooling2D((2,2)),
  # It shown 13 * 13 size image with 32 channel or filter or depth.
  keras.layers.Dropout(0.25),
  # Reduce Overfitting of Training sample drop out 25% Neuron
  keras.layers.Conv2D(64, (3,3), activation='relu'),
  # Deeper layers use 64 filters
  # 3*3 is Size of Filter
  # Observe how the input image on 28x28x1 is transformed to a 3x3x64 feature map
  # 13(Size)-3(Filter Size )+1(bias)=11 Size for Width and Height with 64 Depth or filtter or channel
  # in Paramter shwon 18496 is value of weights: (3x3 filter weights + 64 bias) * 64 filters
  # 64*3*3=576+1=577*32 + 32(bias)=18496
keras.layers.MaxPooling2D((2,2)),
  # It shown 5 * 5 size image with 64 channel or filter or depth.
keras.layers.Dropout(0.25),
```

```
    keras.layers.Conv2D(128, (3,3), activation='relu'),
   # Deeper layers use 128 filters
   # 3*3 is Size of Filter
   # Observe how the input image on 28x28x1 is transformed to a 3x3x128 feature map
     # It show 5(Size)-3(Filter Size )+1(bias)=3 Size for Width and Height with 64 Depth or filtter or
channel
   # 128*3*3=1152+1=1153*64 + 64(bias)= 73856
   # To classify the images, we still need a Dense and Softmax layer.
   # We need to flatten the 3x3x128 feature map to a vector of size 1152
     keras.layers.Flatten(),
   keras.layers.Dense(128, activation='relu'),
   # 128 Size of Node in Dense Layer
   # 1152*128 = 147584
   keras.layers.Dropout(0.25),
   keras.layers.Dense(10, activation='softmax')
   # 10 Size of Node another Dense Layer
   # 128*10+10 bias= 1290
])
model.summary()
```

Model: "sequential"

```
_________________________________________________________________
 Layer (type)              Output Shape           Param #
=================================================================
 conv2d (Conv2D)           (None, 26, 26, 32)       320

 max_pooling2d (MaxPooling2D (None, 13, 13, 32)       0
 )

 dropout (Dropout)         (None, 13, 13, 32)       0

 conv2d_1 (Conv2D)         (None, 11, 11, 64)       18496

 max_pooling2d_1 (MaxPooling (None, 5, 5, 64)         0
 2D)

 dropout_1 (Dropout)       (None, 5, 5, 64)         0
```

```
conv2d_2 (Conv2D)        (None, 3, 3, 128)       73856

flatten (Flatten)        (None, 1152)            0

dense (Dense)            (None, 128)             147584

dropout_2 (Dropout)      (None, 128)             0

dense_1 (Dense)          (None, 10)              1290

=================================================================
Total params: 241,546
Trainable params: 241,546
Non-trainable params: 0
# Compile and Train the Model
# After defining the model, we will compile it and train it on the training data.
model.compile(optimizer='adam', loss='sparse_categorical_crossentropy', metrics=['accuracy'])
history = model.fit(x_train, y_train, epochs=10, validation_data=(x_test, y_test))
# 1875 is a number of batches. By default batches contain 32 samles.60000 / 32 = 1875
# Finally, we will evaluate the performance of the model on the test data.
test_loss, test_acc = model.evaluate(x_test, y_test)
print('Test accuracy:', test_acc)
313/313 [==============================] - 3s 10ms/step - loss: 0.2606 - accuracy: 0.9031
Test accuracy: 0.9031000137329102
```

Conclusion- In this way we can Classify fashion clothing into categories using CNN.

Assignment Question

1. What is MNIST dataset for classification?
2. How many classes are in the MNIST dataset?
3. What is 784 in MNIST dataset?
4. How many epochs are there in MNIST?
5. What are the hardest digits in MNIST?