Importing Necessary Libraries

# Program 2: Fashion MNIST

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**Course:** MCA B (AI & DS)
**Batch:** 2025–2027

In [1]:
```
import tensorflow as tf
from tensorflow.keras.datasets import fashion_mnist
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Dropout, Flatten, Conv2D, MaxPooling2
from tensorflow.keras.utils import to_categorical
import matplotlib.pyplot as plt
```

In [2]:
```
# Load MNIST dataset using minst dataset module
(x_train, y_train), (x_test, y_test) = fashion_mnist.load_data()
#saving it as training set and test set( split it as )
```

In [3]:
```
x_train.shape
#60000 images of 28x28 pixels in training set)
```

Out[3]:
```
(60000, 28, 28)
```

In [4]:
```
x_test.shape
#10000 images of 28x28 pixels in test set)
```

Out[4]:
```
(10000, 28, 28)
```

In [5]:
```
print(y_test)
#labels of test set
```

```
[9 2 1 ... 8 1 5]
```

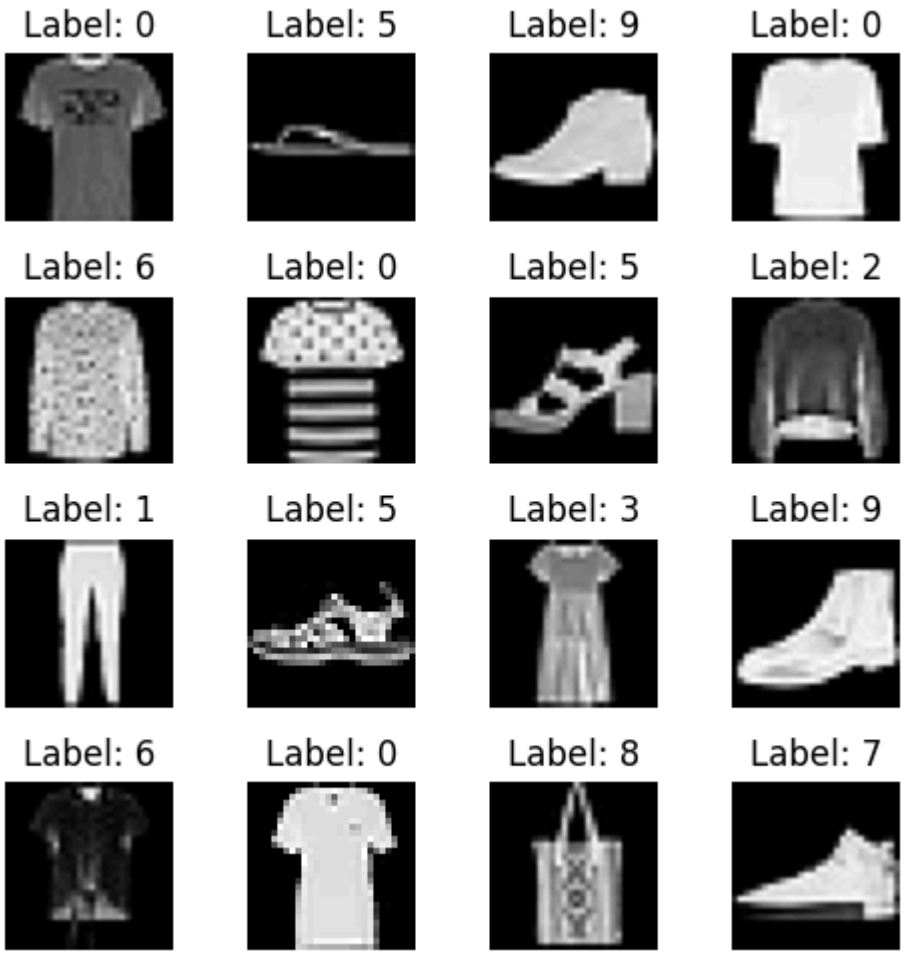
In [6]:
```
#Displaying Sample Images from the MNIST Dataset
# Select random indices for displaying images
import numpy as np
indices = np.random.randint(0, x_train.shape[0], size=16)
```

In [7]:
```
# Create a figure and subplots
fig, axes = plt.subplots(4, 4, figsize=(5, 5))

# Flatten the axes array for easy iteration
axes = axes.flatten()

for i, ax in enumerate(axes):
    image = x_train[indices[i]]
    label = y_train[indices[i]]
    ax.imshow(image, cmap='gray')
    ax.set_title(f"Label: {label}")
    ax.axis('off')
```

```
plt.tight_layout()
plt.show()
```




In [8]:
```
# Reshape data for CNN input
#CNNs expect input data to have a specific shape, typically (num_samples, img_ro
img_rows, img_cols = 28, 28
x_train = x_train.reshape(x_train.shape[0], img_rows, img_cols, 1)#shape[0] = ho
x_test = x_test.reshape(x_test.shape[0], img_rows, img_cols, 1)
```

In [9]:
```
x_train.shape
#x_test.shape
#1 stands for 1 channel , if color images we will have 3 channels (RGB)
```

Out[9]:
```
(60000, 28, 28, 1)
```

In [10]:
```
# Normalize pixel values to be between 0 and 1
x_train = x_train / 255.0 # To normalize the pixel values, we divide by 255 (the
x_test = x_test / 255.0
```

In [11]:
```
# Convert class vectors to binary class matrices

num_classes = 10 # Number of classes in the MNIST dataset (digits 0-9)
y_train = to_categorical(y_train, num_classes) #1 hotencoding the labels
y_test = to_categorical(y_test, num_classes)
```

In [12]:
```
print(y_test)
```

```
[[0. 0. 0. ... 0. 0. 1.]
 [0. 0. 1. ... 0. 0. 0.]
 [0. 1. 0. ... 0. 0. 0.]
 ...
 [0. 0. 0. ... 0. 1. 0.]
 [0. 1. 0. ... 0. 0. 0.]
 [0. 0. 0. ... 0. 0. 0.]]
```

In [13]:
```
# Create a CNN model
model = Sequential()# 32 kernels , general we choose odd dimension for kernal si
model.add(Conv2D(32, kernel_size=(3, 3),strides=(1,1),padding='same', activation
model.add(MaxPooling2D(pool_size=(2, 2),padding='same'))#2 x 2 blank kernal
model.add(Flatten()) # only 1 convolution layer and 1 pooling layer, so we need
model.add(Dense(128, activation='relu'))#128 neurons or any no of neurons THIS I
model.add(Dense(num_classes, activation='softmax'))#according to the no of neuro
```

```
c:\Users\user\Desktop\MCA AI DS 2027\S2\Deep Learning\Lab\tfenv\lib\site-packages
\keras\src\layers\convolutional\base_conv.py:113: UserWarning: Do not pass an `in
put_shape`/`input_dim` argument to a layer. When using Sequential models, prefer
using an `Input(shape)` object as the first layer in the model instead.
  super().__init__(activity_regularizer=activity_regularizer, **kwargs)
```

In [14]:
```
# Compile the model
model.compile(loss='categorical_crossentropy', optimizer='adam', metrics=['accur
#this is a classification Problem so we use categorical_crossentropy as the loss
# 2 class classfiction , them binary_crossentropy use karte hai
# advanced optimizers : RMSprop, Adam, Adagrad, Adadelta
#accuracy to evaluate the model , trained well or not
```

In [15]:
```
# Train the model
#model.fit() standard attributes
# history variable will store the training history, which includes the loss and
# Trying to train model with x_train and y_train  , batch size of 128 each , tot
#epoch = can be decided by us ,
#get trained batch wise , accuracy is the training set accuracy , then the test
history=model.fit(x_train, y_train, batch_size=128, epochs=10, verbose=1, valida
```

```
Epoch 1/10
469/469 ━━━━━━━━━━━━━━━━━━━━ 17s 34ms/step - accuracy: 0.8428 - loss: 0.4483 - va
l_accuracy: 0.8797 - val_loss: 0.3456
Epoch 2/10
469/469 ━━━━━━━━━━━━━━━━━━━━ 17s 36ms/step - accuracy: 0.8947 - loss: 0.2980 - va
l_accuracy: 0.8903 - val_loss: 0.3093
Epoch 3/10
469/469 ━━━━━━━━━━━━━━━━━━━━ 16s 35ms/step - accuracy: 0.9079 - loss: 0.2570 - va
l_accuracy: 0.9001 - val_loss: 0.2754
Epoch 4/10
469/469 ━━━━━━━━━━━━━━━━━━━━ 15s 32ms/step - accuracy: 0.9172 - loss: 0.2268 - va
l_accuracy: 0.9007 - val_loss: 0.2742
Epoch 5/10
469/469 ━━━━━━━━━━━━━━━━━━━━ 16s 34ms/step - accuracy: 0.9255 - loss: 0.2045 - va
l_accuracy: 0.9071 - val_loss: 0.2600
Epoch 6/10
469/469 ━━━━━━━━━━━━━━━━━━━━ 15s 32ms/step - accuracy: 0.9317 - loss: 0.1876 - va
l_accuracy: 0.9129 - val_loss: 0.2503
Epoch 7/10
469/469 ━━━━━━━━━━━━━━━━━━━━ 15s 31ms/step - accuracy: 0.9382 - loss: 0.1700 - va
l_accuracy: 0.9126 - val_loss: 0.2482
Epoch 8/10
469/469 ━━━━━━━━━━━━━━━━━━━━ 15s 32ms/step - accuracy: 0.9433 - loss: 0.1542 - va
l_accuracy: 0.9157 - val_loss: 0.2508
Epoch 9/10
469/469 ━━━━━━━━━━━━━━━━━━━━ 17s 36ms/step - accuracy: 0.9493 - loss: 0.1404 - va
l_accuracy: 0.9182 - val_loss: 0.2452
Epoch 10/10
469/469 ━━━━━━━━━━━━━━━━━━━━ 16s 33ms/step - accuracy: 0.9544 - loss: 0.1249 - va
l_accuracy: 0.9121 - val_loss: 0.2667
```

In [16]:
```
model.summary()
```

**Model: "sequential"**

| Layer (type) | Output Shape | Param # |
|---|---|---|
| conv2d (Conv2D) | (None, 28, 28, 32) | 320 |
| max_pooling2d (MaxPooling2D) | (None, 14, 14, 32) | 0 |
| flatten (Flatten) | (None, 6272) | 0 |
| dense (Dense) | (None, 128) | 802,944 |
| dense_1 (Dense) | (None, 10) | 1,290 |

**Total params:** 2,413,664 (9.21 MB)

**Trainable params:** 804,554 (3.07 MB)

**Non-trainable params:** 0 (0.00 B)

**Optimizer params:** 1,609,110 (6.14 MB)

In [17]:
```
# Evaluate the model on the test set
test_loss, test_acc = model.evaluate(x_test, y_test)
print('Test accuracy:', test_acc)
```

```
313/313 ━━━━━━━━━━━━━━━━━━━━ 1s 3ms/step - accuracy: 0.9121 - loss: 0.2667
Test accuracy: 0.9121000170707703
```

In [18]:
```
plt.figure(figsize=(14, 5))

plt.subplot(1, 2, 1)
plt.plot(history.history['accuracy'], label='Training Accuracy')
plt.plot(history.history['val_accuracy'], label='Validation Accuracy')
plt.legend(loc='lower right')
plt.title('Training and Validation Accuracy')

plt.subplot(1, 2, 2)
plt.plot(history.history['loss'], label='Training Loss')
plt.plot(history.history['val_loss'], label='Validation Loss')
plt.legend(loc='upper right')
plt.title('Training and Validation Loss')

plt.savefig('./foo.png')
plt.show()
```