```
import numpy as np
import matplotlib.pyplot as plt
import tensorflow as tf
from tensorflow.keras.datasets import mnist
from tensorflow.keras.utils import to_categorical
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv2D, MaxPooling2D, Flatten,
Dense, Dropout
```

Load dataset

```
(x_train, y_train), (x_test, y_test) = mnist.load_data()
```

```
Downloading data from https://storage.googleapis.com/tensorflow/tf-
keras-datasets/mnist.npz
11490434/11490434 ━━━━━━━━━━━━━━━━━━━━ 3s 0us/step
```

Reshape to fit the model (28x28 images with 1 channel)

```
x_train = x_train.reshape(-1, 28, 28, 1).astype('float32') / 255
x_test = x_test.reshape(-1, 28, 28, 1).astype('float32') / 255
```

One-hot encode labels

```
y_train = to_categorical(y_train, 10)
y_test = to_categorical(y_test, 10)
```

Build the CNN Model

```
model = Sequential([
    Conv2D(32, kernel_size=(3,3), activation='relu',
input_shape=(28,28,1)),
    MaxPooling2D(pool_size=(2,2)),

    Conv2D(64, kernel_size=(3,3), activation='relu'),
    MaxPooling2D(pool_size=(2,2)),

    Flatten(),
    Dropout(0.5),
    Dense(128, activation='relu'),
```

```
    Dense(10, activation='softmax')
])
```

```
C:\Users\Sandipan Jana\AppData\Roaming\Python\Python312\site-packages\
keras\src\layers\convolutional\base_conv.py:107: UserWarning: Do not
pass an `input_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)
```

Compile the Model

```
model.compile(optimizer='adam', loss='categorical_crossentropy',
metrics=['accuracy'])
```

Train the Model

```
history = model.fit(x_train, y_train, epochs=10, batch_size=128,
validation_split=0.1)
```

```
Epoch 1/10
422/422 ━━━━━━━━━━━━━━━━━━━━ 17s 33ms/step - accuracy: 0.8183 - loss:
0.5768 - val_accuracy: 0.9815 - val_loss: 0.0652
Epoch 2/10
422/422 ━━━━━━━━━━━━━━━━━━━━ 13s 31ms/step - accuracy: 0.9689 - loss:
0.0950 - val_accuracy: 0.9878 - val_loss: 0.0496
Epoch 3/10
422/422 ━━━━━━━━━━━━━━━━━━━━ 13s 31ms/step - accuracy: 0.9797 - loss:
0.0676 - val_accuracy: 0.9892 - val_loss: 0.0373
Epoch 4/10
422/422 ━━━━━━━━━━━━━━━━━━━━ 13s 31ms/step - accuracy: 0.9838 - loss:
0.0538 - val_accuracy: 0.9887 - val_loss: 0.0373
Epoch 5/10
422/422 ━━━━━━━━━━━━━━━━━━━━ 13s 31ms/step - accuracy: 0.9863 - loss:
0.0434 - val_accuracy: 0.9915 - val_loss: 0.0277
Epoch 6/10
422/422 ━━━━━━━━━━━━━━━━━━━━ 13s 32ms/step - accuracy: 0.9882 - loss:
0.0370 - val_accuracy: 0.9920 - val_loss: 0.0272
Epoch 7/10
422/422 ━━━━━━━━━━━━━━━━━━━━ 13s 30ms/step - accuracy: 0.9887 - loss:
0.0349 - val_accuracy: 0.9922 - val_loss: 0.0268
Epoch 8/10
422/422 ━━━━━━━━━━━━━━━━━━━━ 13s 30ms/step - accuracy: 0.9893 - loss:
0.0326 - val_accuracy: 0.9918 - val_loss: 0.0268
Epoch 9/10
422/422 ━━━━━━━━━━━━━━━━━━━━ 21s 30ms/step - accuracy: 0.9905 - loss:
0.0284 - val_accuracy: 0.9888 - val_loss: 0.0366
```

```
Epoch 10/10
422/422 ━━━━━━━━━━━━━━━━━━━━ 13s 32ms/step - accuracy: 0.9916 - loss:
0.0254 - val_accuracy: 0.9940 - val_loss: 0.0217
```

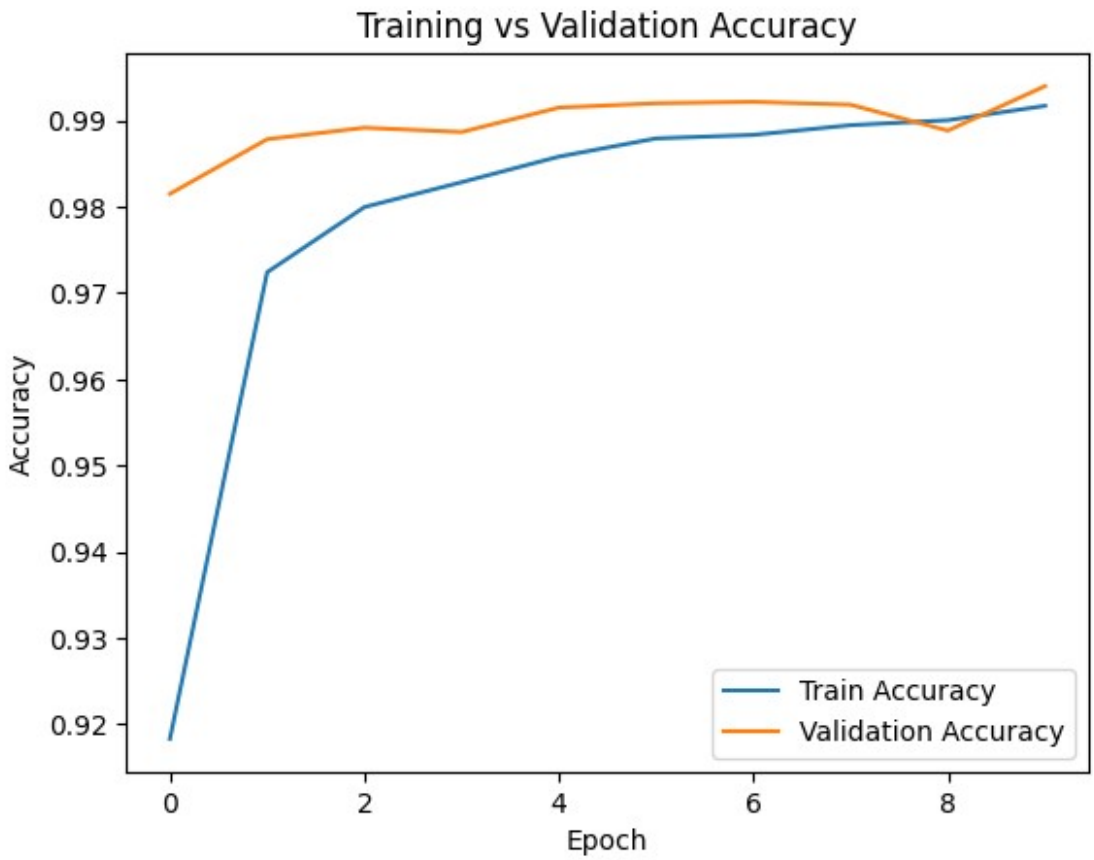
Evaluate the Model

```
test_loss, test_acc = model.evaluate(x_test, y_test)
print(f"Test Accuracy: {test_acc:.4f}")
```

```
313/313 ━━━━━━━━━━━━━━━━━━━━ 2s 7ms/step - accuracy: 0.9901 - loss:
0.0257
Test Accuracy: 0.9930
```

Visualize Training Performance

```
plt.plot(history.history['accuracy'], label='Train Accuracy')
plt.plot(history.history['val_accuracy'], label='Validation Accuracy')
plt.xlabel('Epoch')
plt.ylabel('Accuracy')
plt.legend()
plt.title('Training vs Validation Accuracy')
plt.show()
```



UI to Draw and Predict Digits (Basic Version)