In [1]:
```
pip install tensorflow
```

```
Collecting tensorflow
  Obtaining dependency information for tensorflow from https://files.pythonhosted.org/packages/ed/b6/62345568cd07de5d9254fcf64d7e44aacbb6abde11ea953b3cb320e58d19/tensorflow-2.17.0-cp311-cp311-win_amd64.whl.metadata (https://files.pythonhosted.org/packages/ed/b6/62345568cd07de5d9254fcf64d7e44aacbb6abde11ea953b3cb320e58d19/tensorflow-2.17.0-cp311-cp311-win_amd64.whl.metadata)
  Using cached tensorflow-2.17.0-cp311-cp311-win_amd64.whl.metadata (3.2 kB)
Collecting tensorflow-intel==2.17.0 (from tensorflow)
  Obtaining dependency information for tensorflow-intel==2.17.0 from https://files.pythonhosted.org/packages/66/03/5c447feceb72f5a38ac2aa79d306fa5b5772f982c2b480c1329c7e382900/tensorflow_intel-2.17.0-cp311-cp311-win_amd64.whl.metadata (https://files.pythonhosted.org/packages/66/03/5c447feceb72f5a38ac2aa79d306fa5b5772f982c2b480c1329c7e382900/tensorflow_intel-2.17.0-cp311-cp311-win_amd64.whl.metadata)
  Using cached tensorflow_intel-2.17.0-cp311-cp311-win_amd64.whl.metadata (5.0 kB)
Requirement already satisfied: absl-py>=1.0.0 in c:\users\sheej\anaconda3\lib\site-packages (from tensorflow-intel==2.17.0->tensorflow) (2.1.0)
Requirement already satisfied: astunparse>=1.6.0 in c:\users\sheej\anaconda3\lib\site-packages (from tensorflow-intel==2.17.0->tensorflow) (1.6.3)
Requirement already satisfied: flatbuffers>=24.3.25 in c:\users\sheej\anaconda3\lib\site-packages (from tensorflow-intel==2.17.0->tensorflow) (24.3.25)
Requirement already satisfied: gast!=0.5.0,!=0.5.1,!=0.5.2,>=0.2.1 in c:\users\sheej\anaconda3\lib\site-packages (from tensorflow-intel==2.17.0->tensorflow) (0.6.0)
Requirement already satisfied: google-pasta>=0.1.1 in c:\users\sheej\anaconda3\lib\site-packages (from tensorflow-intel==2.17.0->tensorflow) (0.2.0)
Requirement already satisfied: h5py>=3.10.0 in c:\users\sheej\anaconda3\lib\site-packages (from tensorflow-intel==2.17.0->tensorflow) (3.12.1)
Requirement already satisfied: libclang>=13.0.0 in c:\users\sheej\anaconda3\lib\site-packages (from tensorflow-intel==2.17.0->tensorflow) (18.1.1)
Requirement already satisfied: ml-dtypes<0.5.0,>=0.3.1 in c:\users\sheej\anaconda3\lib\site-packages (from tensorflow-intel==2.17.0->tensorflow) (0.4.1)
Requirement already satisfied: opt-einsum>=2.3.2 in c:\users\sheej\anaconda3\lib\site-packages (from tensorflow-intel==2.17.0->tensorflow) (3.4.0)
Requirement already satisfied: packaging in c:\users\sheej\anaconda3\lib\site-packages (from tensorflow-intel==2.17.0->tensorflow) (23.1)
Requirement already satisfied: protobuf!=4.21.0,!=4.21.1,!=4.21.2,!=4.21.3,!=4.21.4,!=4.21.5,<5.0.0dev,>=3.20.3 in c:\users\sheej\anaconda3\lib\site-packages (from tensorflow-intel==2.17.0->tensorflow) (4.25.5)
Requirement already satisfied: requests<3,>=2.21.0 in c:\users\sheej\anaconda3\lib\site-packages (from tensorflow-intel==2.17.0->tensorflow) (2.31.0)
Requirement already satisfied: setuptools in c:\users\sheej\anaconda3\lib\site-packages (from tensorflow-intel==2.17.0->tensorflow) (68.0.0)
Requirement already satisfied: six>=1.12.0 in c:\users\sheej\anaconda3\lib\site-packages (from tensorflow-intel==2.17.0->tensorflow) (1.16.0)
Requirement already satisfied: termcolor>=1.1.0 in c:\users\sheej\anaconda3\lib\site-packages (from tensorflow-intel==2.17.0->tensorflow) (2.5.0)
Requirement already satisfied: typing-extensions>=3.6.6 in c:\users\sheej\anaconda3\lib\site-packages (from tensorflow-intel==2.17.0->tensorflow) (4.7.1)
Requirement already satisfied: wrapt>=1.11.0 in c:\users\sheej\anaconda3\lib\site-packages (from tensorflow-intel==2.17.0->tensorflow) (1.14.1)
Requirement already satisfied: grpcio<2.0,>=1.24.3 in c:\users\sheej\anaconda3\lib\site-packages (from tensorflow-intel==2.17.0->tensorflow) (1.66.2)
Requirement already satisfied: tensorboard<2.18,>=2.17 in c:\users\sheej\anaconda3\lib\site-packages (from tensorflow-intel==2.17.0->tensorflow) (2.17.1)
Requirement already satisfied: keras>=3.2.0 in c:\users\sheej\anaconda3\lib\site-packages (from tensorflow-intel==2.17.0->tensorflow) (3.6.0)
Requirement already satisfied: tensorflow-io-gcs-filesystem>=0.23.1 in c:\users\sheej\anaconda3\lib\site-packages (from tensorflow-intel==2.17.0->tensorflow) (0.31.0)
Requirement already satisfied: numpy<2.0.0,>=1.23.5 in c:\users\sheej\anaconda3\lib\site-packages (from tensorflow-intel==2.17.0->tensorflow) (1.24.3)
Requirement already satisfied: wheel<1.0,>=0.23.0 in c:\users\sheej\anaconda3\lib\site-packages (from astunparse>=1.6.0->tensorflow-intel==2.17.0->tensorflow) (0.38.4)
Requirement already satisfied: rich in c:\users\sheej\anaconda3\lib\site-packages (from keras>=3.2.0->tensorflow-intel==2.17.0->tensorflow) (13.9.2)
Requirement already satisfied: namex in c:\users\sheej\anaconda3\lib\site-packages
```

```
(from keras>=3.2.0->tensorflow-intel==2.17.0->tensorflow) (0.0.8)
Requirement already satisfied: optree in c:\users\sheej\anaconda3\lib\site-packages
(from keras>=3.2.0->tensorflow-intel==2.17.0->tensorflow) (0.13.0)
Requirement already satisfied: charset-normalizer<4,>=2 in c:\users\sheej\anaconda3
\lib\site-packages (from requests<3,>=2.21.0->tensorflow-intel==2.17.0->tensorflow)
(2.0.4)
Requirement already satisfied: idna<4,>=2.5 in c:\users\sheej\anaconda3\lib\site-pa
ckages (from requests<3,>=2.21.0->tensorflow-intel==2.17.0->tensorflow) (3.4)
Requirement already satisfied: urllib3<3,>=1.21.1 in c:\users\sheej\anaconda3\lib\s
ite-packages (from requests<3,>=2.21.0->tensorflow-intel==2.17.0->tensorflow) (1.2
6.16)
Requirement already satisfied: certifi>=2017.4.17 in c:\users\sheej\anaconda3\lib\s
ite-packages (from requests<3,>=2.21.0->tensorflow-intel==2.17.0->tensorflow) (202
3.7.22)
Requirement already satisfied: markdown>=2.6.8 in c:\users\sheej\anaconda3\lib\site
-packages (from tensorboard<2.18,>=2.17->tensorflow-intel==2.17.0->tensorflow) (3.
4.1)
Requirement already satisfied: tensorboard-data-server<0.8.0,>=0.7.0 in c:\users\sh
eej\anaconda3\lib\site-packages (from tensorboard<2.18,>=2.17->tensorflow-intel==2.
17.0->tensorflow) (0.7.2)
Requirement already satisfied: werkzeug>=1.0.1 in c:\users\sheej\anaconda3\lib\site
-packages (from tensorboard<2.18,>=2.17->tensorflow-intel==2.17.0->tensorflow) (2.
2.3)
Requirement already satisfied: MarkupSafe>=2.1.1 in c:\users\sheej\anaconda3\lib\si
te-packages (from werkzeug>=1.0.1->tensorboard<2.18,>=2.17->tensorflow-intel==2.17.
0->tensorflow) (2.1.1)
Requirement already satisfied: markdown-it-py>=2.2.0 in c:\users\sheej\anaconda3\li
b\site-packages (from rich->keras>=3.2.0->tensorflow-intel==2.17.0->tensorflow) (2.
2.0)
Requirement already satisfied: pygments<3.0.0,>=2.13.0 in c:\users\sheej\anaconda3
\lib\site-packages (from rich->keras>=3.2.0->tensorflow-intel==2.17.0->tensorflow)
(2.15.1)
Requirement already satisfied: mdurl~=0.1 in c:\users\sheej\anaconda3\lib\site-pack
ages (from markdown-it-py>=2.2.0->rich->keras>=3.2.0->tensorflow-intel==2.17.0->ten
sorflow) (0.1.0)
Using cached tensorflow-2.17.0-cp311-cp311-win_amd64.whl (2.0 kB)
Using cached tensorflow_intel-2.17.0-cp311-cp311-win_amd64.whl (385.0 MB)
Installing collected packages: tensorflow-intel, tensorflow
Successfully installed tensorflow-2.17.0 tensorflow-intel-2.17.0
Note: you may need to restart the kernel to use updated packages.
```

In [2]:
```
import tensorflow as tf
print(tf.__version__)
```

```
2.17.0
```

In [3]:
```
import tensorflow as tf
from tensorflow.keras import datasets

# Load the MNIST dataset
(train_images, train_labels), (test_images, test_labels) = datasets.mnist.load_data(
```

```
Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-datasets/m
nist.npz (https://storage.googleapis.com/tensorflow/tf-keras-datasets/mnist.npz)
11490434/11490434 ━━━━━━━━━━━━━━━━━━━━ 2s 0us/step
```

In [4]:
```
# Normalize the images to the range [0, 1]
train_images = train_images.astype('float32') / 255.0
test_images = test_images.astype('float32') / 255.0

# Reshape images to add a channel dimension
train_images = train_images.reshape((train_images.shape[0], 28, 28, 1))
test_images = test_images.reshape((test_images.shape[0], 28, 28, 1))
```

In [5]:
```
from tensorflow.keras import layers, models

# Build the CNN model
model = models.Sequential()
model.add(layers.Conv2D(32, (3, 3), activation='relu', input_shape=(28, 28, 1)))
model.add(layers.Conv2D(64, (3, 3), activation='relu'))
```

```
C:\Users\sheej\anaconda3\Lib\site-packages\keras\src\layers\convolutional\base_con
v.py:107: UserWarning: Do not pass an `input_shape`/`input_dim` argument to a laye
r. 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 [6]:
```
# Add MaxPooling layers
model.add(layers.MaxPooling2D((2, 2)))
model.add(layers.Conv2D(64, (3, 3), activation='relu'))
model.add(layers.MaxPooling2D((2, 2)))
```

In [7]:
```
# Flatten the output and add Dense layers
model.add(layers.Flatten())
model.add(layers.Dense(64, activation='relu'))
model.add(layers.Dense(10, activation='softmax'))  # Output layer
```

In [8]:
```
# Compile the model
model.compile(optimizer='adam',
              loss='sparse_categorical_crossentropy',  # Use sparse_categorical_cros
              metrics=['accuracy'])
```

In [9]:
```
# Train the model and track accuracy/loss
history = model.fit(train_images, train_labels, epochs=10,
                    validation_split=0.2, batch_size=64)
```

```
Epoch 1/10
750/750 ━━━━━━━━━━━━━━━━━━━━ 32s 38ms/step - accuracy: 0.8573 - loss: 0.4299 - val_
accuracy: 0.9794 - val_loss: 0.0654
Epoch 2/10
750/750 ━━━━━━━━━━━━━━━━━━━━ 30s 40ms/step - accuracy: 0.9834 - loss: 0.0553 - val_
accuracy: 0.9877 - val_loss: 0.0427
Epoch 3/10
750/750 ━━━━━━━━━━━━━━━━━━━━ 28s 37ms/step - accuracy: 0.9902 - loss: 0.0335 - val_
accuracy: 0.9869 - val_loss: 0.0464
Epoch 4/10
750/750 ━━━━━━━━━━━━━━━━━━━━ 28s 37ms/step - accuracy: 0.9918 - loss: 0.0251 - val_
accuracy: 0.9895 - val_loss: 0.0325
Epoch 5/10
750/750 ━━━━━━━━━━━━━━━━━━━━ 30s 40ms/step - accuracy: 0.9937 - loss: 0.0189 - val_
accuracy: 0.9875 - val_loss: 0.0435
Epoch 6/10
750/750 ━━━━━━━━━━━━━━━━━━━━ 28s 38ms/step - accuracy: 0.9952 - loss: 0.0152 - val_
accuracy: 0.9898 - val_loss: 0.0386
Epoch 7/10
750/750 ━━━━━━━━━━━━━━━━━━━━ 28s 38ms/step - accuracy: 0.9963 - loss: 0.0113 - val_
accuracy: 0.9902 - val_loss: 0.0356
Epoch 8/10
750/750 ━━━━━━━━━━━━━━━━━━━━ 28s 38ms/step - accuracy: 0.9971 - loss: 0.0089 - val_
accuracy: 0.9908 - val_loss: 0.0413
Epoch 9/10
750/750 ━━━━━━━━━━━━━━━━━━━━ 28s 37ms/step - accuracy: 0.9973 - loss: 0.0093 - val_
accuracy: 0.9900 - val_loss: 0.0408
Epoch 10/10
750/750 ━━━━━━━━━━━━━━━━━━━━ 28s 38ms/step - accuracy: 0.9976 - loss: 0.0066 - val_
accuracy: 0.9883 - val_loss: 0.0579
```

In [10]:
```
# Evaluate the model on test data
test_loss, test_acc = model.evaluate(test_images, test_labels)
print(f'Test accuracy: {test_acc:.4f}')
```

```
313/313 ━━━━━━━━━━━━━━━━━━━━ 3s 8ms/step - accuracy: 0.9854 - loss: 0.0552
Test accuracy: 0.9892
```

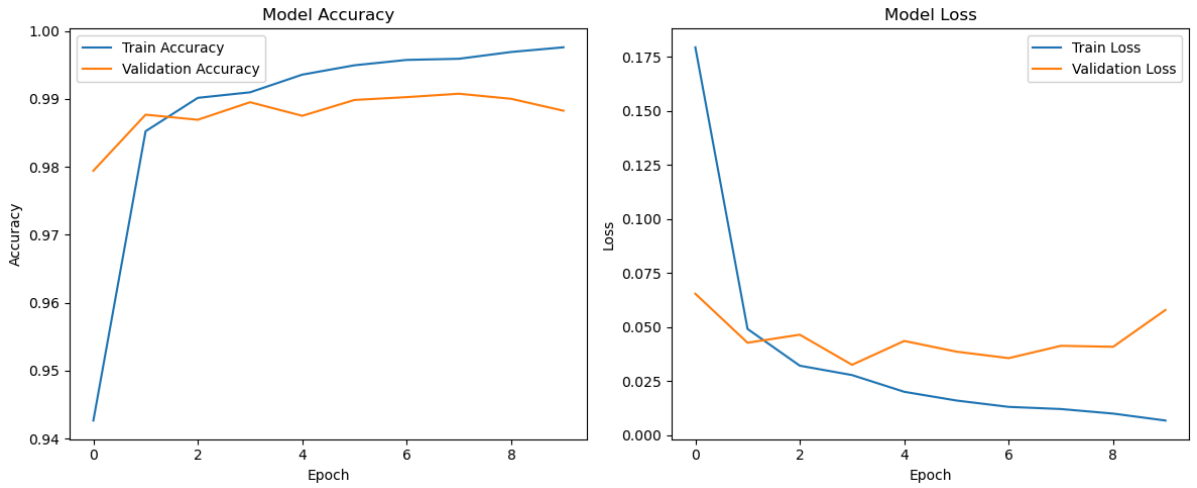
In [11]:
```
import matplotlib.pyplot as plt

# Plot training & validation accuracy values
plt.figure(figsize=(12, 5))

plt.subplot(1, 2, 1)
plt.plot(history.history['accuracy'], label='Train Accuracy')
plt.plot(history.history['val_accuracy'], label='Validation Accuracy')
plt.title('Model Accuracy')
plt.xlabel('Epoch')
plt.ylabel('Accuracy')
plt.legend()

# Plot training & validation loss values
plt.subplot(1, 2, 2)
plt.plot(history.history['loss'], label='Train Loss')
plt.plot(history.history['val_loss'], label='Validation Loss')
plt.title('Model Loss')
plt.xlabel('Epoch')
plt.ylabel('Loss')
plt.legend()

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



In [ ]: