Handwritten Digit Classification

In [1]:
```
# imports
import pandas as pd
import numpy as np
```

In [2]:
```
df_train=pd.read_csv('./mnist_train.csv')
df_test=pd.read_csv('./mnist_test.csv')
```

In [3]:
```
print(df_train.shape)
print(df_test.shape)
```

```
(60000, 785)
(10000, 785)
```

In [4]:
```
df_train.columns
```

Out[4]:
```
Index(['label', '1x1', '1x2', '1x3', '1x4', '1x5', '1x6', '1x7', '1x8', '1x
9',
       ...
       '28x19', '28x20', '28x21', '28x22', '28x23', '28x24', '28x25', '28x2
6',
       '28x27', '28x28'],
      dtype='object', length=785)
```

In [ ]:
```

```

In [5]:
```
# Split into features and labels of train dataset
x_train = df_train.drop('label', axis=1).values
y_train = df_train['label'].values

```

In [6]:
```
# Split into features and labels of test dataset
x_test = df_test.drop('label', axis=1).values
y_test = df_test['label'].values

```

In [7]:
```
from tensorflow.keras.utils import to_categorical

```

In [8]:
```
# Reshape and normalize of train dataset
x_train = x_train .reshape(-1, 28, 28, 1) / 255.0
y_train = to_categorical(y_train , num_classes=10)
```

In [9]:
```
# Reshape and normalize of test dataset
x_test = x_test .reshape(-1, 28, 28, 1) / 255.0
y_test = to_categorical(y_test , num_classes=10)
```

In [10]:
```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(x_train, y_train, test
```

In [11]:
```
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv2D, MaxPooling2D, Flatten, Dense
from tensorflow.keras.utils import to_categorical
```

In [12]:
```
# Define CNN model
model = Sequential([
    Conv2D(32, (3, 3), activation='relu', input_shape=(28, 28, 1)),
    MaxPooling2D((2, 2)),
    Conv2D(64, (3, 3), activation='relu'),
    MaxPooling2D((2, 2)),
    Flatten(),
    Dense(128, activation='relu'),
    Dense(10, activation='softmax')
])
```

```
c:\Users\AB\AppData\Local\Programs\Python\Python311\Lib\site-packages\keras\s
rc\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)
```

In [13]:
```
1 model.summary()
```

Model: "sequential"

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 26, 26, 32)	320
max_pooling2d (MaxPooling2D)	(None, 13, 13, 32)	0
conv2d_1 (Conv2D)	(None, 11, 11, 64)	18,496
max_pooling2d_1 (MaxPooling2D)	(None, 5, 5, 64)	0
flatten (Flatten)	(None, 1600)	0
dense (Dense)	(None, 128)	204,928
dense_1 (Dense)	(None, 10)	1,290

Total params: 225,034 (879.04 KB)

Trainable params: 225,034 (879.04 KB)

Non-trainable params: 0 (0.00 B)

In [14]:
```
1 model.compile(optimizer='adam', loss='categorical_crossentropy', metrics=[
2
```

In [15]:
```
1 from EnergyEfficientAI import EnergyConsumptionDL
2
```

In [16]:
```
1 model.fit(X_train, y_train, epochs=10, validation_data=(X_test, y_test))
```

```
Epoch 1/10
1500/1500 ━━━━━━━━━━━━━━━━━━━━ 48s 29ms/step - accuracy: 0.8949 - loss: 0.336
4 - val_accuracy: 0.9851 - val_loss: 0.0493
Epoch 2/10
1500/1500 ━━━━━━━━━━━━━━━━━━━━ 28s 19ms/step - accuracy: 0.9868 - loss: 0.043
2 - val_accuracy: 0.9867 - val_loss: 0.0433
Epoch 3/10
1500/1500 ━━━━━━━━━━━━━━━━━━━━ 27s 18ms/step - accuracy: 0.9905 - loss: 0.029
4 - val_accuracy: 0.9836 - val_loss: 0.0488
Epoch 4/10
1500/1500 ━━━━━━━━━━━━━━━━━━━━ 27s 18ms/step - accuracy: 0.9931 - loss: 0.020
5 - val_accuracy: 0.9903 - val_loss: 0.0330
Epoch 5/10
1500/1500 ━━━━━━━━━━━━━━━━━━━━ 28s 18ms/step - accuracy: 0.9951 - loss: 0.014
7 - val_accuracy: 0.9912 - val_loss: 0.0349
Epoch 6/10
1500/1500 ━━━━━━━━━━━━━━━━━━━━ 27s 18ms/step - accuracy: 0.9960 - loss: 0.011
9 - val_accuracy: 0.9911 - val_loss: 0.0377
Epoch 7/10
1500/1500 ━━━━━━━━━━━━━━━━━━━━ 42s 19ms/step - accuracy: 0.9973 - loss: 0.009
3 - val_accuracy: 0.9905 - val_loss: 0.0407
Epoch 8/10
1500/1500 ━━━━━━━━━━━━━━━━━━━━ 28s 18ms/step - accuracy: 0.9969 - loss: 0.009
3 - val_accuracy: 0.9900 - val_loss: 0.0461
Epoch 9/10
1500/1500 ━━━━━━━━━━━━━━━━━━━━ 28s 19ms/step - accuracy: 0.9987 - loss: 0.003
7 - val_accuracy: 0.9898 - val_loss: 0.0503
Epoch 10/10
1500/1500 ━━━━━━━━━━━━━━━━━━━━ 58s 30ms/step - accuracy: 0.9976 - loss: 0.007
6 - val_accuracy: 0.9893 - val_loss: 0.0504
```

Out[16]:
```
<keras.src.callbacks.history.History at 0x1a7f3dc1490>
```

In [17]:
```
1 predictions = model.predict(X_test)
```

```
375/375 ━━━━━━━━━━━━━━━━━━━━ 5s 12ms/step
```

In [18]:
```
1 predicted_labels = np.argmax(predictions, axis=1)
2
3 # If you want to check the predictions for the first 5 samples:
4 for i in range(5):
5     print(f"Predicted label: {predicted_labels[i]}, True label: {np.argmax
```

```
Predicted label: 7, True label: 7
Predicted label: 3, True label: 3
Predicted label: 8, True label: 8
Predicted label: 9, True label: 9
Predicted label: 3, True label: 3
```

In [19]:
```
1 print("Done")
```

```
Done
```

image test

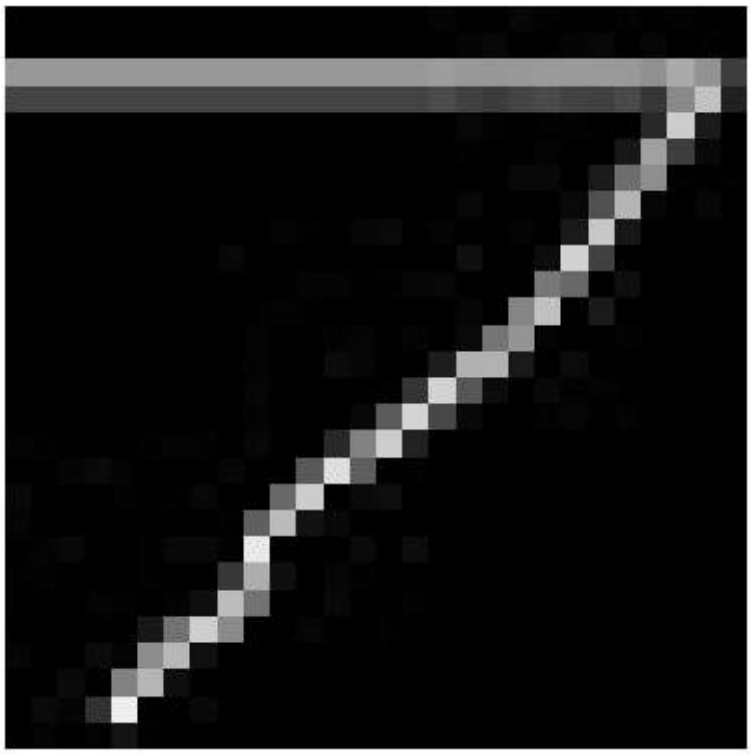
In [20]:
```
from PIL import Image


```

In [29]:
```
import matplotlib.pyplot as plt

# Load an image
img = Image.open("./dh.jpg")

# Display the image
plt.imshow(img)
plt.axis("off")  # Hide axes for better display
plt.show()
```



In [30]:
```
image_data = np.array(img).reshape(-1, 28, 28, 1) / 255.0  # normalize
```

In [31]:
```
prediction = model.predict(image_data)
predicted_label = int(np.argmax(prediction))
```

```
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 42ms/step
```

In [32]:
```
print(f"Prediction:{predicted_label}")
```

```
Prediction:7
```

model file

In [90]:
```
1 model.save("mnist_cnn_model2.h5")
```

```
WARNING:absl:You are saving your model as an HDF5 file via `model.save()` or
`keras.saving.save_model(model)`. This file format is considered legacy. We r
ecommend using instead the native Keras format, e.g. `model.save('my_model.ke
ras')` or `keras.saving.save_model(model, 'my_model.keras')`.
```

In [ ]:
```
1
```