

```
In [1]: from data_loader import load_mnist, show_image
import os
current_dir = os.getcwd()
project_root = os.path.dirname(current_dir)
data_dir = os.path.join(project_root, 'data')
train_images, train_labels = load_mnist(data_dir, kind='train')
test_images, test_labels = load_mnist(data_dir, kind='t10k')
show_image(train_images, train_labels, test_images, test_labels)
```

```
+-----+-----+-----+
| Dataset | Images Shape | Labels Shape |
+-----+-----+-----+
| Train   | (60000, 784) | (60000,)      |
| Test    | (10000, 784) | (10000,)      |
+-----+-----+-----+
```

## Train Images (First 30)



```
In [1]: import torch
import torch.nn as nn
import torch.optim as optim
```

```

import numpy as np
import time
import logging
from pathlib import Path

torch.manual_seed(42)
np.random.seed(42)

device = torch.device('cuda' if torch.cuda.is_available() else 'cpu')

Path("logs").mkdir(exist_ok=True)
Path("models").mkdir(exist_ok=True)

logging.basicConfig(
    filename='logs/training.log',
    level=logging.INFO,
    format='%(asctime)s - %(message)s'
)

```

```

In [2]: from cnn_model import FashionCNN, print_model
model = FashionCNN().to(device)
print_model(model)
criterion = nn.CrossEntropyLoss()
optimizer = optim.Adam(model.parameters(), lr=0.001)

```

Param	Shape	Num #
conv1.weight	(32, 1, 3, 3)	288
conv1.bias	(32,)	32
bn1.weight	(32,)	32
bn1.bias	(32,)	32
conv2.weight	(64, 32, 3, 3)	18432
conv2.bias	(64,)	64
bn2.weight	(64,)	64
bn2.bias	(64,)	64
fc1.weight	(512, 3136)	1605632
fc1.bias	(512,)	512
fc2.weight	(10, 512)	5120
fc2.bias	(10,)	10

=====  
Total params: 1630282

```

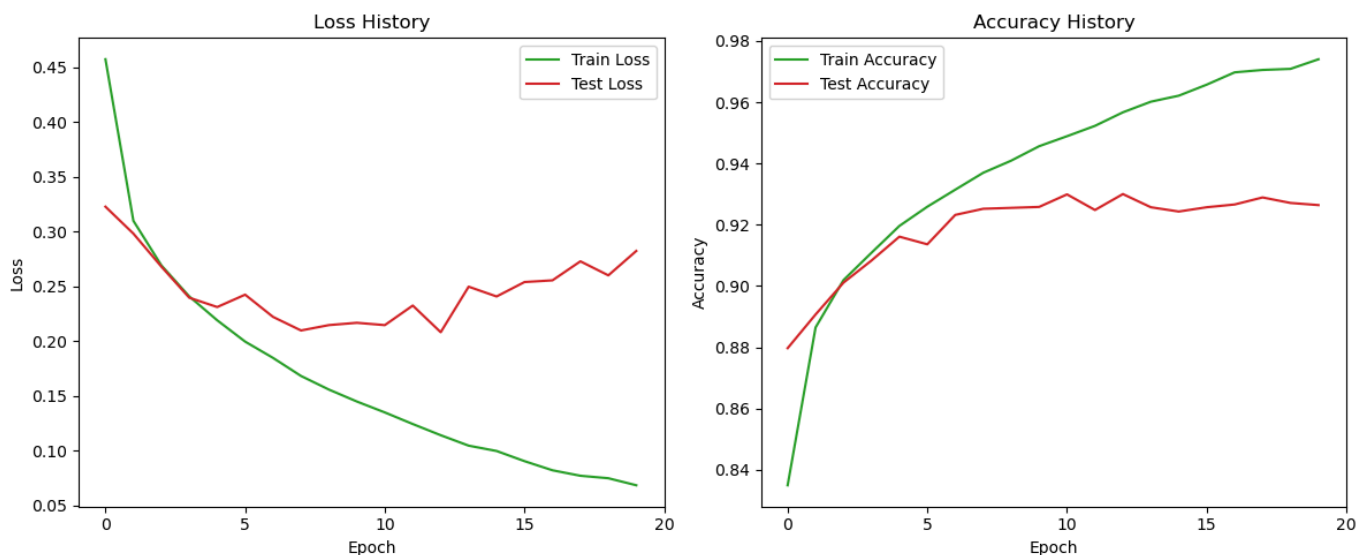
In [4]: from train import train_model, preprocess_data
train_loader, test_loader = preprocess_data(train_images, train_labels, test_images, test_labels)
# 训练模型
start_time = time.time()
train_loss, train_acc, test_loss, test_acc = train_model(
    model, train_loader, test_loader, criterion, optimizer, num_epochs=20
)
print(f'Training completed in {time.time()-start_time:.2f} seconds')

```

Epoch [1/20]	Train Loss: 0.4571	Acc: 0.8349	Test Loss: 0.3226	Acc: 0.8797
Epoch [2/20]	Train Loss: 0.3098	Acc: 0.8865	Test Loss: 0.2981	Acc: 0.8907
Epoch [3/20]	Train Loss: 0.2692	Acc: 0.9019	Test Loss: 0.2680	Acc: 0.9011
Epoch [4/20]	Train Loss: 0.2408	Acc: 0.9108	Test Loss: 0.2396	Acc: 0.9083
Epoch [5/20]	Train Loss: 0.2190	Acc: 0.9196	Test Loss: 0.2311	Acc: 0.9161
Epoch [6/20]	Train Loss: 0.1996	Acc: 0.9259	Test Loss: 0.2424	Acc: 0.9136
Epoch [7/20]	Train Loss: 0.1847	Acc: 0.9314	Test Loss: 0.2221	Acc: 0.9232
Epoch [8/20]	Train Loss: 0.1682	Acc: 0.9369	Test Loss: 0.2097	Acc: 0.9252
Epoch [9/20]	Train Loss: 0.1558	Acc: 0.9409	Test Loss: 0.2146	Acc: 0.9255
Epoch [10/20]	Train Loss: 0.1449	Acc: 0.9456	Test Loss: 0.2167	Acc: 0.9258
Epoch [11/20]	Train Loss: 0.1350	Acc: 0.9489	Test Loss: 0.2146	Acc: 0.9299
Epoch [12/20]	Train Loss: 0.1244	Acc: 0.9523	Test Loss: 0.2325	Acc: 0.9248
Epoch [13/20]	Train Loss: 0.1142	Acc: 0.9567	Test Loss: 0.2081	Acc: 0.9300
Epoch [14/20]	Train Loss: 0.1047	Acc: 0.9601	Test Loss: 0.2497	Acc: 0.9257
Epoch [15/20]	Train Loss: 0.0998	Acc: 0.9621	Test Loss: 0.2407	Acc: 0.9243
Epoch [16/20]	Train Loss: 0.0905	Acc: 0.9657	Test Loss: 0.2539	Acc: 0.9257
Epoch [17/20]	Train Loss: 0.0822	Acc: 0.9697	Test Loss: 0.2554	Acc: 0.9266
Epoch [18/20]	Train Loss: 0.0772	Acc: 0.9705	Test Loss: 0.2728	Acc: 0.9289
Epoch [19/20]	Train Loss: 0.0750	Acc: 0.9709	Test Loss: 0.2600	Acc: 0.9271
Epoch [20/20]	Train Loss: 0.0685	Acc: 0.9740	Test Loss: 0.2823	Acc: 0.9264

Training completed in 479.75 seconds

```
In [5]: from plot import plot_confusion_matrix, visualize_history
visualize_history(train_loss, train_acc, test_loss, test_acc)
```

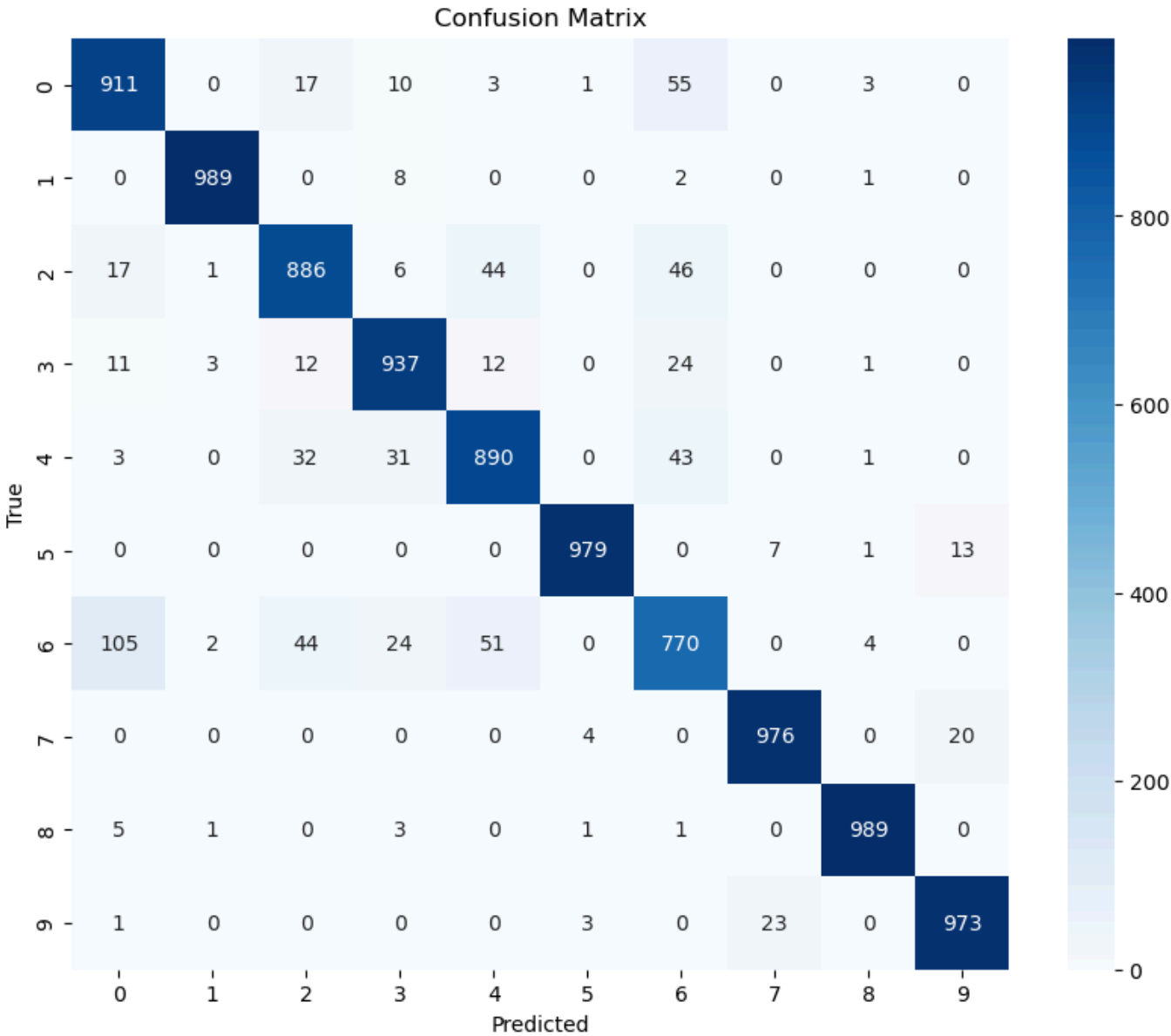


```
In [7]: from predict import evaluate_model
# 加载最佳模型并绘制混淆矩阵
model.load_state_dict(torch.load('models/best_model.pth'))
final_loss, final_acc = evaluate_model(model, test_loader, criterion)
print(f'Best Model Test Accuracy: {final_acc:.4f}')
plot_confusion_matrix(model, test_loader)

# 验证所有保存模型的准确率
model_files = sorted(Path('models').glob('model_epoch_*.pth'))
results = []
for model_file in model_files:
    model.load_state_dict(torch.load(model_file))
    _, acc = evaluate_model(model, test_loader, criterion)
    epoch = int(model_file.stem.split('_')[-1])
    results.append((epoch, acc))

# 打印结果表格
from prettytable import PrettyTable
table = PrettyTable()
table.field_names = ["Epoch", "Test Accuracy"]
for epoch, acc in sorted(results):
    table.add_row([epoch, f"{acc:.4f}"])
print(table)
```

Best Model Test Accuracy: 0.9300



Epoch	Test Accuracy
1	0.8797
2	0.8907
3	0.9011
4	0.9083
5	0.9161
6	0.9136
7	0.9232
8	0.9252
9	0.9255
10	0.9258
11	0.9299
12	0.9248
13	0.9300
14	0.9257
15	0.9243
16	0.9257
17	0.9266
18	0.9289
19	0.9271
20	0.9264