11/08/2025

SIMPLE FEED FORWARD NEURAL NETWORK.

AIM

To build a train a simple feedforward neural network for handwritten digits classification using the MNIST datasets

OBJECTIVE:

* Load and preprocess the MNIST DATASET.
* Design a simple neural network with one hidden layer
* Train the network on the training data.
* Evaluate the trained model on the test data.
* Achieve good accuracy in classifying handwritten digits (0-9).

PSEUDOCODE:

START.

1. Import necessary lib.
2. Load MNIST data set with transforms (normalize to tensor)
3. Create DataLoader for batching training and test data.
4. Define feedforward Neural Network:
   - → Flatten input img (28x28 to 784)
   - → Fully connected layer with 128 neuron + ReLU activation.
   - → Outputlayer with 10 neurons (one / digit class)

5. Initialize model, loss function (Cross Entropy loss) optimizer (Adam)

6. FOR each epoch in number of epochs DO
   → Set model to training mode
   → FOR each batch in training data DO
      → Zero gradients
      → Forward pass input through the network
      → Calculate loss
      → Back propagate loss
      → Update weights with optimizer

7. → END FOR

8. Print final test accuracy and loss

OBSERVATION:

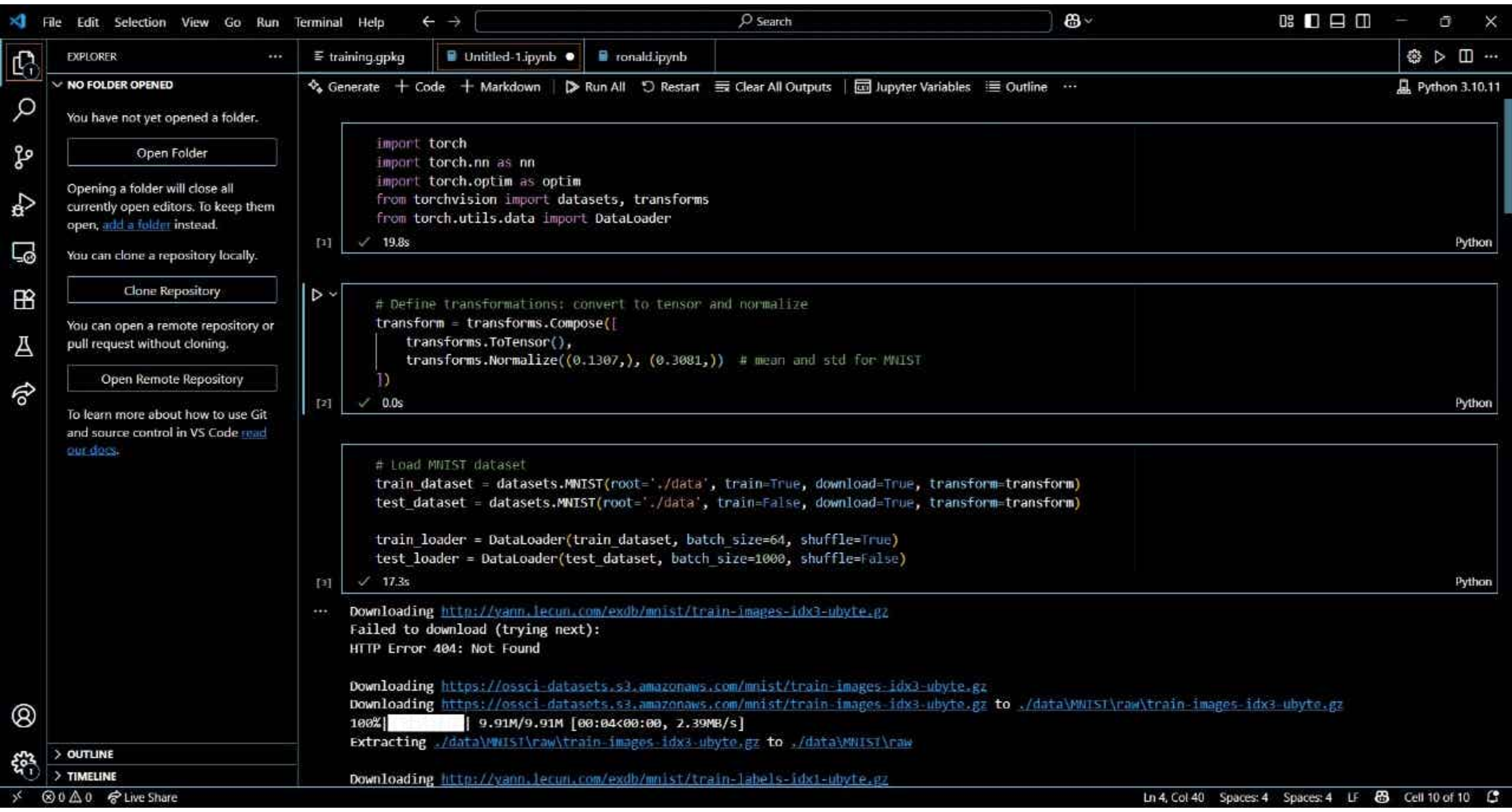
→ Accuracy increases and loss decreases after every epoch.
→ with 5 epochs Accuracy is Around 97.46%.

Test set : Average loss : 0.0846, Accuracy : 9746/10000 (97.46%)

8%

RESULT:

The simple feedforward neural network successfully learns to classify handwritten digits.



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Outline
Python 3.10.11
import torch
import torch.nn as nn
import torch.optim as optim
from torchvision import datasets, transforms
from torch.utils.data import DataLoader
[1]
19.8s
Python
# Define transformations: convert to tensor and normalize
transform = transforms.Compose([
transforms.ToTensor(),
transforms.Normalize((0.1307,), (0.3081,)) # mean and std for MNIST
])
[2]
0.0s
Python
# Load MNIST dataset
train_dataset = datasets.MNIST(root='./data', train=True, download=True, transform=transform)
test_dataset = datasets.MNIST(root='./data', train=False, download=True, transform=transform)
train_loader = DataLoader(train_dataset, batch_size=64, shuffle=True)
test_loader = DataLoader(test_dataset, batch_size=1000, shuffle=False)
[3]
17.3s
Python
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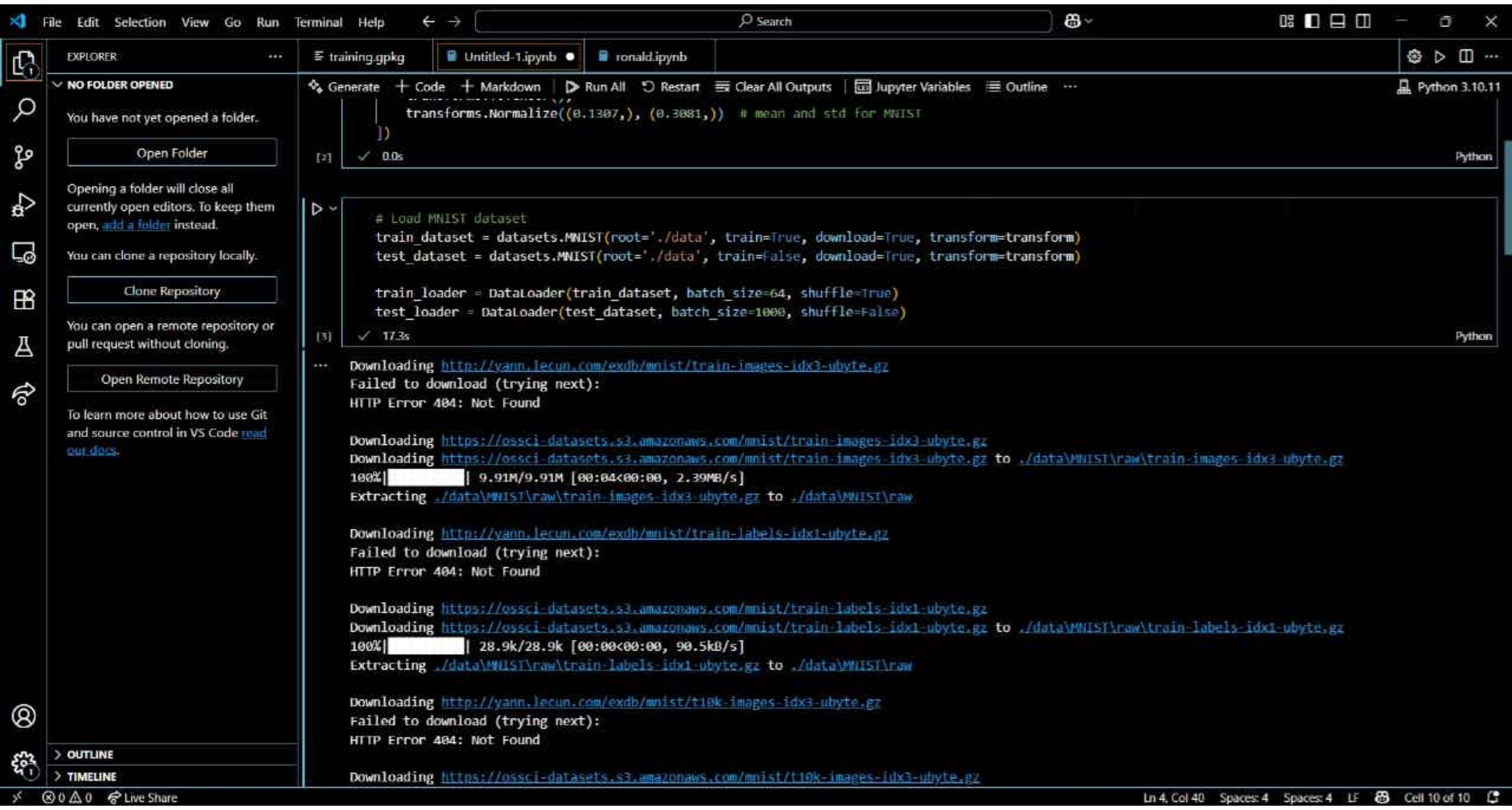
Cell 10 of 10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Cell 10 of 10
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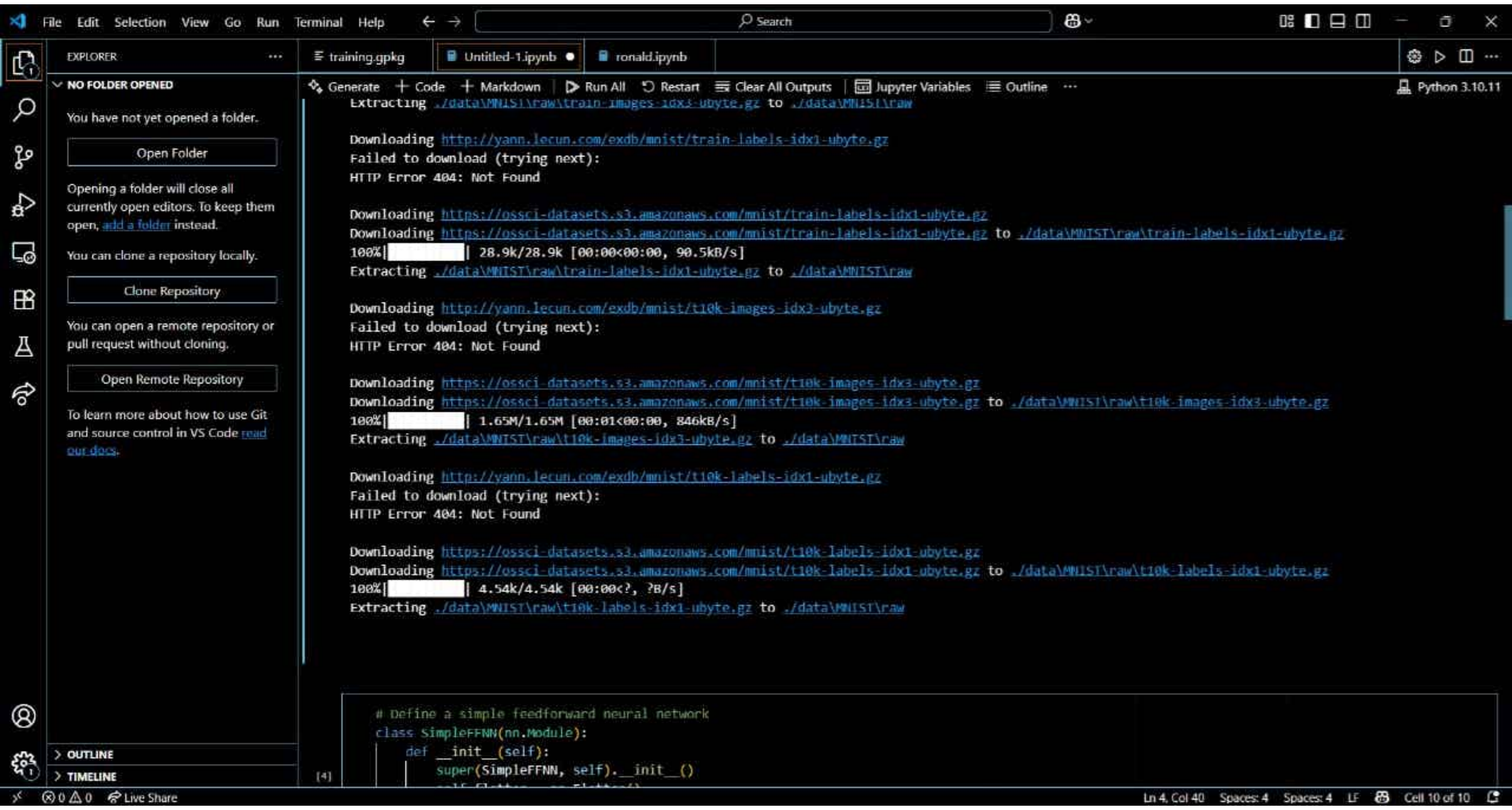
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# Define a simple feedforward neural network
class SimpleFFNN(nn.Module):
def __init__(self):
super(SimpleFFNN, self).__init__()
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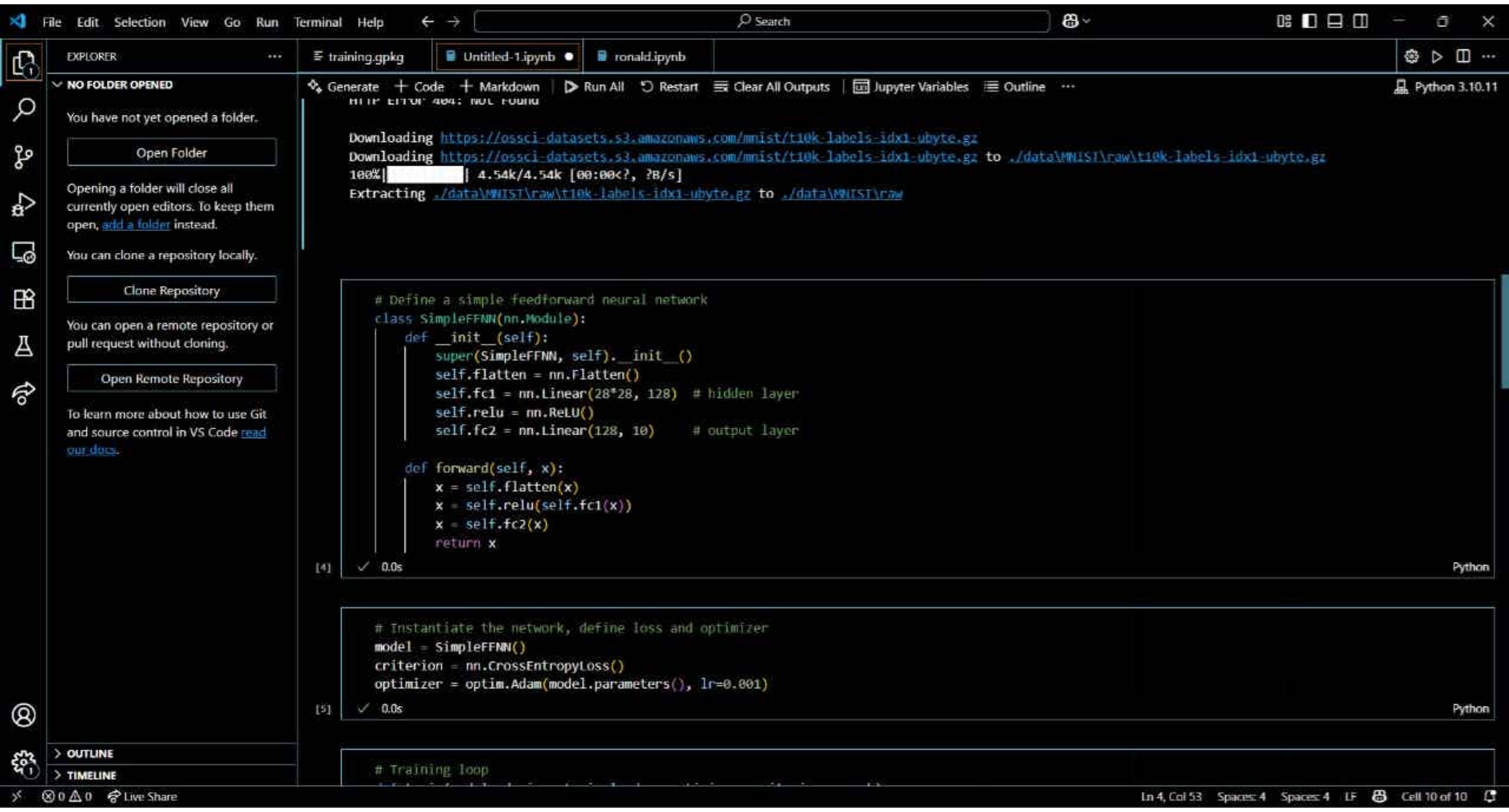
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class SimpleFFNN(nn.Module):
def __init__(self):
super(SimpleFFNN, self).__init__()
self.flatten = nn.Flatten()
self.fc1 = nn.Linear(28*28, 128) # hidden layer
self.relu = nn.ReLU()
self.fc2 = nn.Linear(128, 10)   # output layer
def forward(self, x):
x = self.flatten(x)
x = self.relu(self.fc1(x))
x = self.fc2(x)
return x
[4]
0.0s
Python
# Instantiate the network, define loss and optimizer
model = SimpleFFNN()
criterion = nn.CrossEntropyLoss()
optimizer = optim.Adam(model.parameters(), lr=0.001)
[5]
0.0s
Python
Training loop
Live Share
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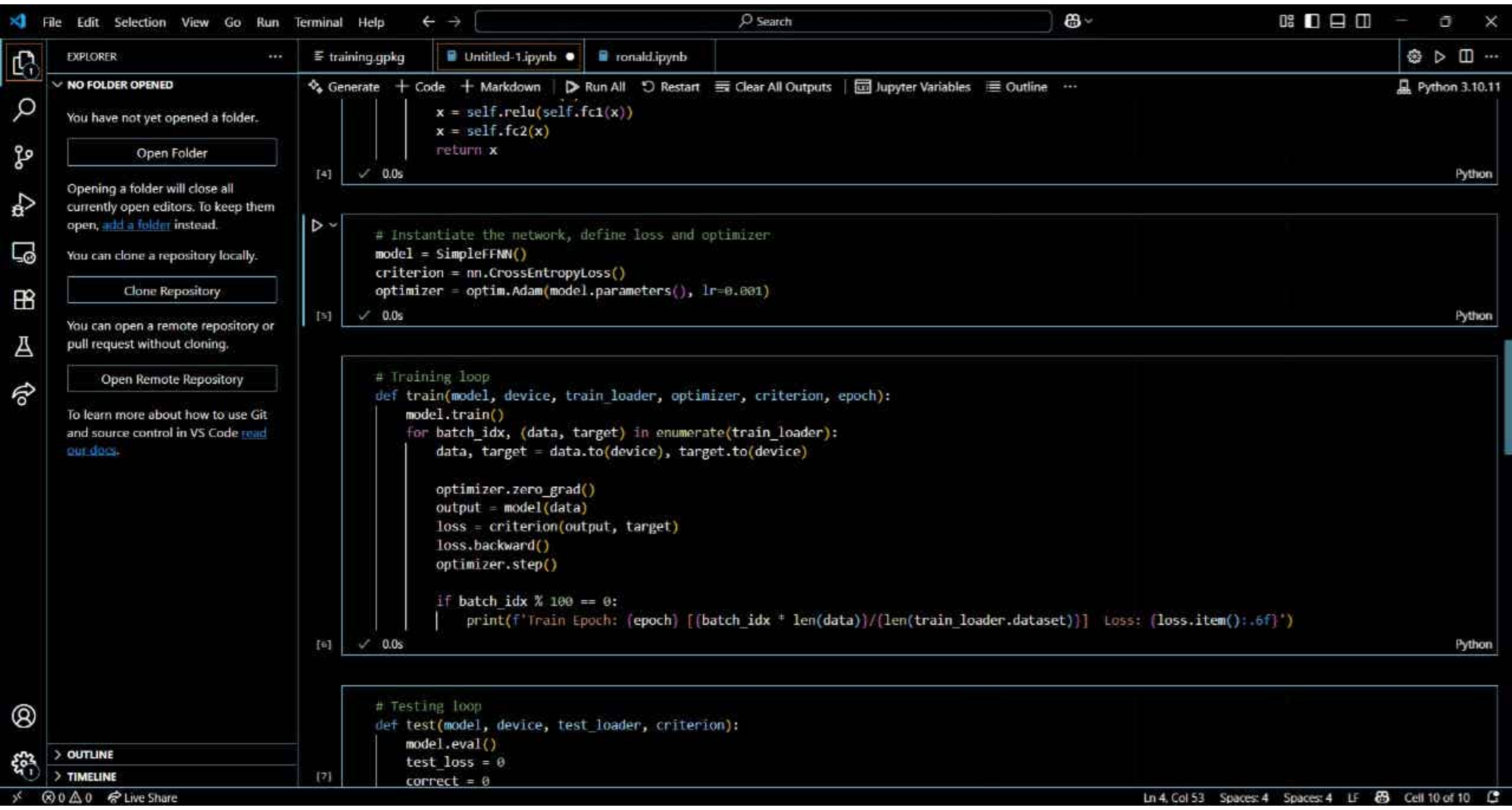
Cell 10 of 10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x = self.relu(self.fc1(x))
x = self.fc2(x)
return x
[4]
0.0s
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model = SimpleFFNN()
criterion = nn.CrossEntropyLoss()
optimizer = optim.Adam(model.parameters(), lr=0.001)
[5]
0.0s
Python
# Training loop
def train(model, device, train_loader, optimizer, criterion, epoch):
model.train()
for batch_idx, (data, target) in enumerate(train_loader):
data, target = data.to(device), target.to(device)
optimizer.zero_grad()
output = model(data)
loss = criterion(output, target)
loss.backward()
optimizer.step()
if batch_idx % 100 == 0:
print(f'Train Epoch: {epoch} [{batch_idx * len(data)}/{len(train_loader.dataset)}] Loss: {loss.item():.6f}')
[6]
0.0s
Python
# Testing loop
def test(model, device, test_loader, criterion):
model.eval()
test_loss = 0
correct = 0
[7]
0 0
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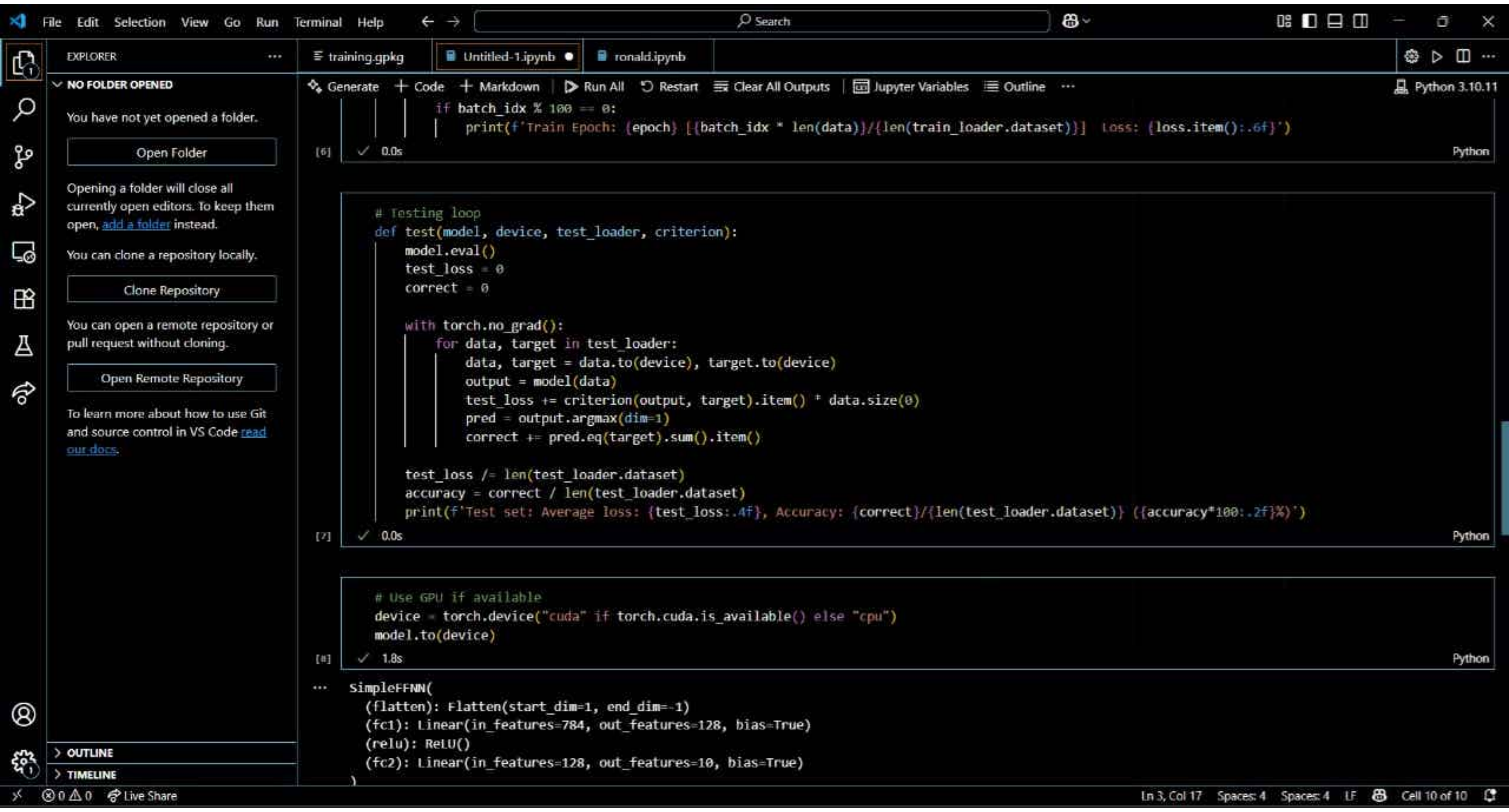
Cell 10 of 10



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Outline
Python 3.10.11
if batch_idx % 100 == 0:
print(f'Train Epoch: {epoch} [{batch_idx * len(data)}/{len(train_loader.dataset)}] Loss: {loss.item():.6f}')
[6]
0.0s
Python
# Testing loop
def test(model, device, test_loader, criterion):
model.eval()
test_loss = 0
correct = 0
with torch.no_grad():
for data, target in test_loader:
data, target = data.to(device), target.to(device)
output = model(data)
test_loss += criterion(output, target).item() * data.size(0)
pred = output.argmax(dim=1)
correct += pred.eq(target).sum().item()
test_loss /= len(test_loader.dataset)
accuracy = correct / len(test_loader.dataset)
print(f'Test set: Average loss: {test_loss:.4f}, Accuracy: {correct}/{len(test_loader.dataset)} ({accuracy*100:.2f}%)')
[7]
0.0s
Python
# Use GPU if available
device = torch.device("cuda" if torch.cuda.is_available() else "cpu")
model.to(device)
[8]
1.8s
Python
SimpleFFNN(
(flatten): Flatten(start_dim=1, end_dim=-1)
(fc1): Linear(in_features=784, out_features=128, bias=True)
(relu): ReLU()
(fc2): Linear(in_features=128, out_features=10, bias=True)
)
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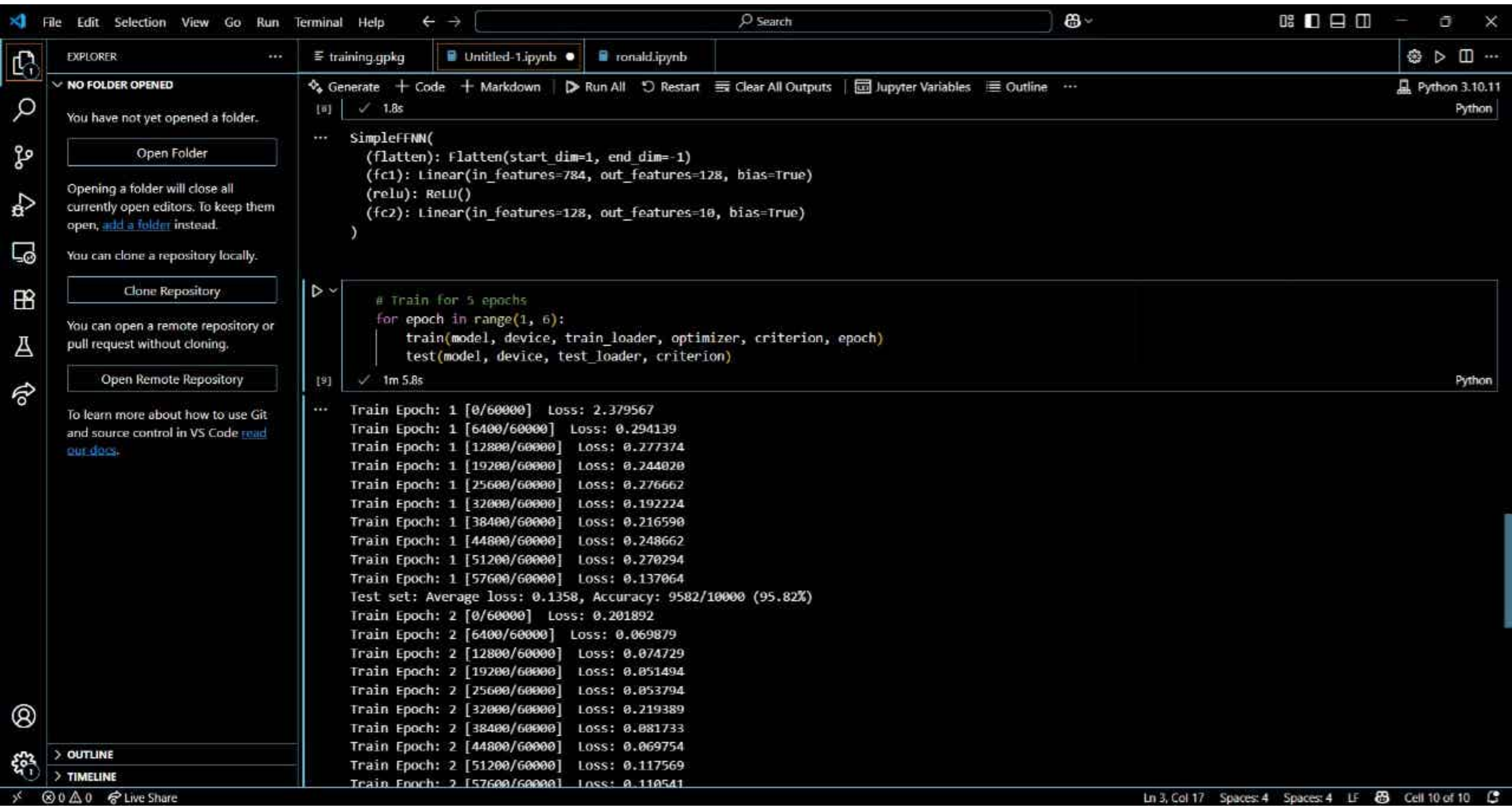

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Code
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(relu): ReLU()
(fc2): Linear(in_features=128, out_features=10, bias=True)
)
# Train for 5 epochs
for epoch in range(1, 6):
train(model, device, train_loader, optimizer, criterion, epoch)
test(model, device, test_loader, criterion)
[9] 1m 5.8s
Python
Train Epoch: 1 [0/60000] Loss: 2.379567
Train Epoch: 1 [6400/60000] Loss: 0.294139
Train Epoch: 1 [12800/60000] Loss: 0.277374
Train Epoch: 1 [19200/60000] Loss: 0.244020
Train Epoch: 1 [25600/60000] Loss: 0.276662
Train Epoch: 1 [32000/60000] Loss: 0.192224
Train Epoch: 1 [38400/60000] Loss: 0.216590
Train Epoch: 1 [44800/60000] Loss: 0.248662
Train Epoch: 1 [51200/60000] Loss: 0.270294
Train Epoch: 1 [57600/60000] Loss: 0.137064
Test set: Average loss: 0.1358, Accuracy: 9582/10000 (95.82%)
Train Epoch: 2 [0/60000] Loss: 0.201892
Train Epoch: 2 [6400/60000] Loss: 0.069879
Train Epoch: 2 [12800/60000] Loss: 0.074729
Train Epoch: 2 [19200/60000] Loss: 0.051494
Train Epoch: 2 [25600/60000] Loss: 0.053794
Train Epoch: 2 [32000/60000] Loss: 0.219389
Train Epoch: 2 [38400/60000] Loss: 0.081733
Train Epoch: 2 [44800/60000] Loss: 0.069754
Train Epoch: 2 [51200/60000] Loss: 0.117569
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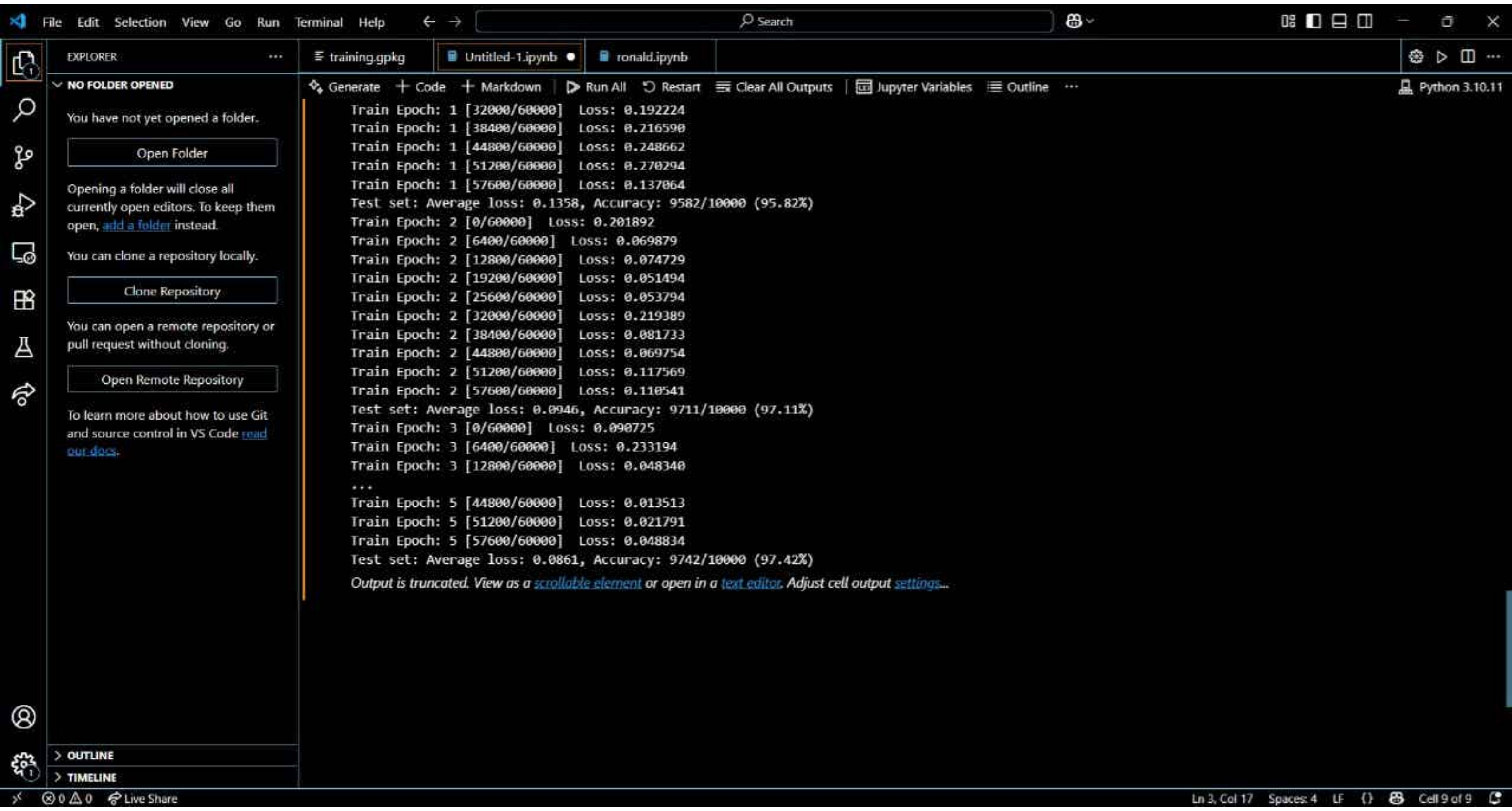
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Train Epoch: 2 [44800/60000] Loss: 0.069754
Train Epoch: 2 [51200/60000] Loss: 0.117569
Train Epoch: 2 [57600/60000] Loss: 0.110541
Test set: Average loss: 0.0946, Accuracy: 9711/10000 (97.11%)
Train Epoch: 3 [0/60000] Loss: 0.090725
Train Epoch: 3 [6400/60000] Loss: 0.233194
Train Epoch: 3 [12800/60000] Loss: 0.048340
...
Train Epoch: 5 [44800/60000] Loss: 0.013513
Train Epoch: 5 [51200/60000] Loss: 0.021791
Train Epoch: 5 [57600/60000] Loss: 0.048834
Test set: Average loss: 0.0861, Accuracy: 9742/10000 (97.42%)
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