CNN_VGG

April 9, 2025

[56]:

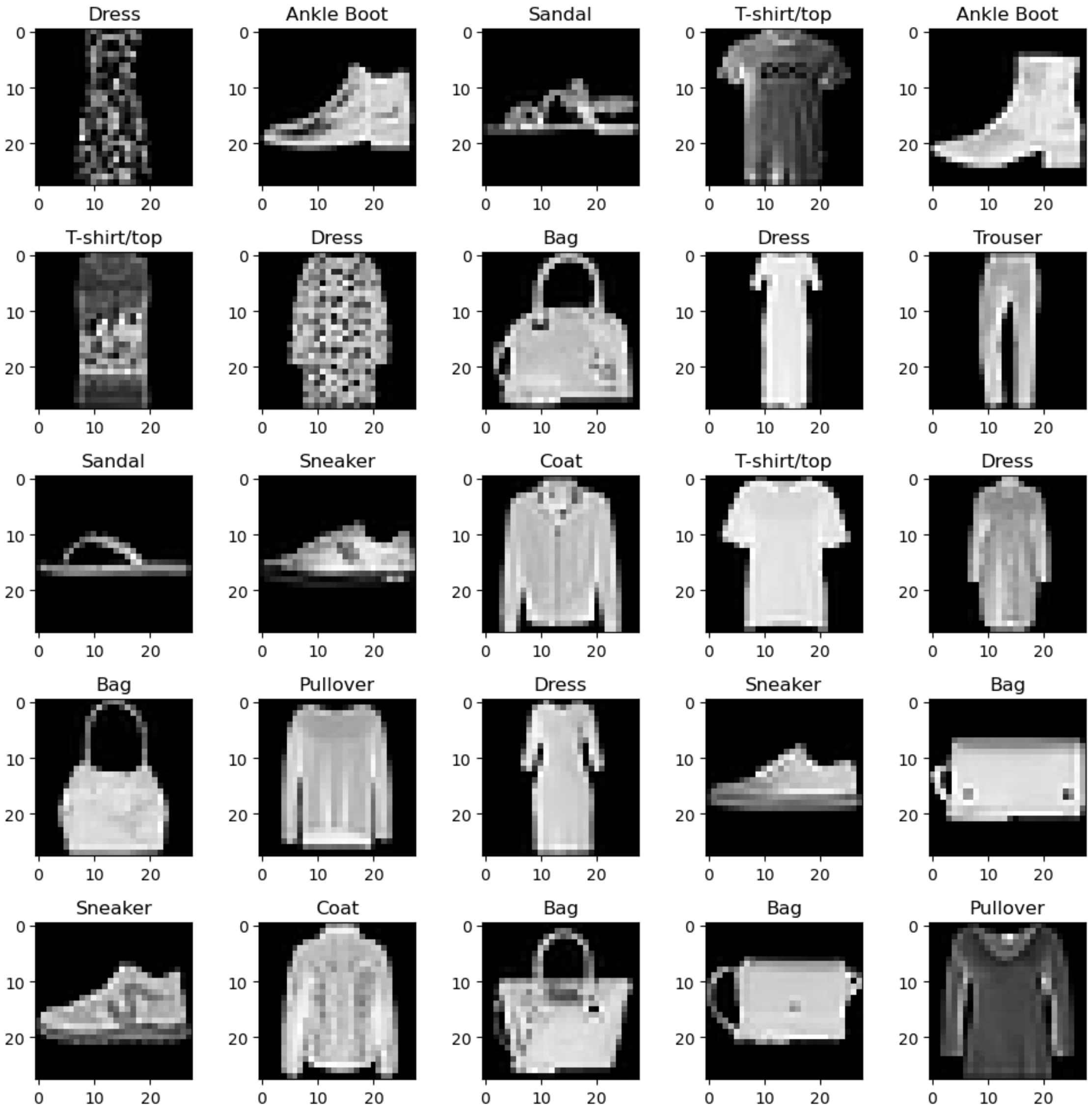
```
import pandas as pd
import numpy as np
import torch
import os
torch.set_num_threads(os.cpu_count())
from torch import optim as optim
from torch import nn as nn
import torch.nn.functional as F
import matplotlib.pyplot as plt
import torchvision
import torchvision.transforms as transforms
import random
np.random.seed(0)
torch.manual_seed(0)
random.seed(0)
```

[57]:

```
transform = transforms.ToTensor()

training_set = torchvision.datasets.FashionMNIST('./data', train=True,␣
 ↪transform=transform, download=True)
validation_set = torchvision.datasets.FashionMNIST('./data', train=False,␣
 ↪transform=transform, download=True)

training_loader = torch.utils.data.DataLoader(training_set, batch_size=128,␣
 ↪shuffle=True, num_workers=os.cpu_count())
validation_loader = torch.utils.data.DataLoader(validation_set, batch_size=128,␣
 ↪shuffle=False, num_workers=os.cpu_count())
```

[3]:

```
classes = ('T-shirt/top', 'Trouser', 'Pullover', 'Dress', 'Coat',
        'Sandal', 'Shirt', 'Sneaker', 'Bag', 'Ankle Boot')
batch = next(iter(training_loader))
plt.figure(figsize=(10, 10))
for i, (image, label) in enumerate(zip(*batch)):
    if i > 24:
        break
    plt.subplot(5, 5, i + 1)
    plt.imshow(image[0], cmap="gray")
    plt.title(classes[label])

plt.tight_layout()
```



[64]:
```
print(image.shape)
```

```
torch.Size([1, 28, 28])
```

[65]:
```
device = torch.device("cuda" if torch.cuda.is_available() else "cpu")
print(f"Using device: {device}")
```

```
Using device: cpu
```

1 Model

[75]:

```python
class CNN(nn.Module):
    def __init__(self, image_channels=1, num_classes=10):
        super().__init__()
        self.conv1 = nn.Conv2d(in_channels=image_channels, out_channels=64, kernel_size=5, stride=1, padding=1)
        self.pool = nn.MaxPool2d(kernel_size=2, stride=1)
        self.conv2 = nn.Conv2d(in_channels=64, out_channels=128, kernel_size=5, stride=1, padding=1)
        with torch.no_grad():
            dummy = torch.zeros(1, 1, 28, 28)
            out = self.pool(F.relu(self.conv1(dummy)))
            out = self.pool(F.relu(self.conv2(out)))
            flatten_dim = out.view(1, -1).shape[1]

        self.fc1 = nn.Linear(flatten_dim, 256)
        self.fc2 = nn.Linear(256, num_classes)

    def forward(self, x):
        x = F.relu(self.conv1(x))
        x = self.pool(x)
        x = F.relu(self.conv2(x))
        x = self.pool(x)
        x = torch.flatten(x, 1)
        x = F.relu(self.fc1(x))
        x = self.fc2(x)

        return x
```

[76]:

```python
model = CNN(image_channels=1, num_classes=10).to(device)
```

2 Optimizer

[77]:

```python
optimizer = optim.Adam(model.parameters(), lr=0.001)
```

[78]:

```python
from tqdm import tqdm
loss_fn = nn.CrossEntropyLoss()

def train_model(model, optimizer, training_loader, criterion=loss_fn, no_epochs=5):
    model.train()
    batches = []
    losses = []
    j = 0
    for epoch in range(no_epochs):  # Don't wrap this with tqdm
        running_loss = 0
        correct = 0
        total = 0

        loop = tqdm(enumerate(training_loader), total=len(training_loader),␣
 ↪desc=f"Epoch {epoch+1}/{no_epochs}")

        for i, (images, labels) in loop:
            images, labels = images.to(device), labels.to(device)
            optimizer.zero_grad()
            outputs = model(images)
            loss = criterion(outputs, labels)
            loss.backward()
            optimizer.step()

            running_loss += loss.item()
            _, predicted = torch.max(outputs.data, 1)
            total += labels.size(0)
            correct += (predicted == labels).sum().item()

            # Update tqdm with current metrics
            loop.set_postfix(loss=loss.item(), accuracy=100 * correct / total)

            if i % 100 == 99:
                avg_loss = running_loss / 100
                losses.append(avg_loss)
                j += i
                batches.append(j)
                print(f"Epoch: {epoch}, Batch: {i+1}, Loss: {avg_loss:.3f},␣
 ↪Accuracy: {100 * correct / total:.2f}%")
                running_loss = 0

        if epoch % 2 == 0:
            print(f"Epoch {epoch+1} completed")

    return model, losses, batches
```

[79]:

```
def plot_loss(losses, batches):
    plt.plot(batches, losses)
    plt.xlabel('Batches')
    plt.ylabel('Loss')
    plt.title('Loss vs. Batches')
    plt.show()
```

[80]:

```
model1, losses, batches = train_model(model, optimizer, training_loader,␣
 ↪loss_fn, no_epochs=3)
```

```
Epoch 1/3:   3%|          | 16/469 [00:30<14:34,  1.93s/it, accuracy=54.9,
loss=0.769]
```

```
---------------------------------------------------------------------------
KeyboardInterrupt                         Traceback (most recent call last)
Cell In[80], line 1
----> 1 model1, losses, batches = train_model(model, optimizer, training_loader, loss_fn, no_epochs=3)

Cell In[78], line 20, in train_model(model, optimizer, training_loader, criterion, no_epochs)
     18 images, labels = images.to(device), labels.to(device)
     19 optimizer.zero_grad()
---> 20 outputs = model(images)
     21 loss = criterion(outputs, labels)
     22 loss.backward()

File ~/miniconda3/lib/python3.10/site-packages/torch/nn/modules/module.py:1553, in Module._wrapped_call_impl(self, *args, **kwargs)
   1551     return self._compiled_call_impl(*args, **kwargs)  # type: ignore[misc]
   1552 else:
-> 1553     return self._call_impl(*args, **kwargs)

File ~/miniconda3/lib/python3.10/site-packages/torch/nn/modules/module.py:1562, in Module._call_impl(self, *args, **kwargs)
   1557 # If we don't have any hooks, we want to skip the rest of the logic in
   1558 # this function, and just call forward.
   1559 if not (self._backward_hooks or self._backward_pre_hooks or self._forward_hooks or self._forward_pre_hooks
   1560         or _global_backward_pre_hooks or _global_backward_hooks
   1561         or _global_forward_hooks or _global_forward_pre_hooks):
-> 1562     return forward_call(*args, **kwargs)
   1564 try:
   1565     result = None

Cell In[75], line 19, in CNN.forward(self, x)
     17 x = F.relu(self.conv1(x))
     18 x = self.pool(x)
---> 19 x = F.relu(self.conv2(x))
     20 x = self.pool(x)
     21 x = torch.flatten(x, 1)

File ~/miniconda3/lib/python3.10/site-packages/torch/nn/modules/module.py:1553, in Module._wrapped_call_impl(self, *args, **kwargs)
   1551     return self._compiled_call_impl(*args, **kwargs)  # type: ignore[misc]
   1552 else:
-> 1553     return self._call_impl(*args, **kwargs)

File ~/miniconda3/lib/python3.10/site-packages/torch/nn/modules/module.py:1562,
 ↪in Module._call_impl(self, *args, **kwargs)
   1557 # If we don't have any hooks, we want to skip the rest of the logic in
   1558 # this function, and just call forward.
   1559 if not (self._backward_hooks or self._backward_pre_hooks or self.
 ↪_forward_hooks or self._forward_pre_hooks
   1560         or _global_backward_pre_hooks or _global_backward_hooks
   1561         or _global_forward_hooks or _global_forward_pre_hooks):
-> 1562     return forward_call(*args, **kwargs)
   1564 try:
   1565     result = None

File ~/miniconda3/lib/python3.10/site-packages/torch/nn/modules/conv.py:458, in
 ↪Conv2d.forward(self, input)
    457 def forward(self, input: Tensor) -> Tensor:
--> 458     return self._conv_forward(input, self.weight, self.bias)

File ~/miniconda3/lib/python3.10/site-packages/torch/nn/modules/conv.py:454, in
 ↪Conv2d._conv_forward(self, input, weight, bias)
    450 if self.padding_mode != 'zeros':
    451     return F.conv2d(F.pad(input, self._reversed_padding_repeated_twice,
 ↪mode=self.padding_mode),
    452                     weight, bias, self.stride,
    453                     _pair(0), self.dilation, self.groups)
--> 454 return F.conv2d(input, weight, bias, self.stride,
    455                 self.padding, self.dilation, self.groups)

KeyboardInterrupt:
```

[73]:

```python
def evaluate_model(model, loader):
    model.eval()  # Set the model to evaluation mode
    correct = 0   # Counter for correctly classified samples
    total = 0


    with torch.no_grad():
        for images, labels in loader:
            images = images.view(-1, 28 * 28)  # Iterate through the DataLoader
            outputs = model(images)
            _, predicted = torch.max(outputs.data, 1)

            # Update total sample count
            total += labels.size(0)
            correct += (predicted == labels).sum().item()

    print(f"\nTest Accuracy: {100 * correct / total:.2f}%")
```

[ ]:
```
plt.figure(figsize=(10, 5))
plot_loss(losses, batches)
```

[74]:
```
evaluate_model(model1, validation_loader)
```

```
---------------------------------------------------------------------------
RuntimeError                              Traceback (most recent call last)
Cell In[74], line 1
----> 1 evaluate_model(model1, validation_loader)

Cell In[73], line 10, in evaluate_model(model, loader)
      8 for images, labels in loader:
      9     images = images.view(-1, 28 * 28)  # Iterate through the DataLoader
---> 10     outputs = model(images)
     11     _, predicted = torch.max(outputs.data, 1)
     13     # Update total sample count

File ~/miniconda3/lib/python3.10/site-packages/torch/nn/modules/module.py:1553,␣
 ↪in Module._wrapped_call_impl(self, *args, **kwargs)
   1551     return self._compiled_call_impl(*args, **kwargs)  # type:␣
 ↪ignore[misc]
   1552 else:
-> 1553     return self._call_impl(*args, **kwargs)

File ~/miniconda3/lib/python3.10/site-packages/torch/nn/modules/module.py:1562,␣
 ↪in Module._call_impl(self, *args, **kwargs)
   1557 # If we don't have any hooks, we want to skip the rest of the logic in
   1558 # this function, and just call forward.
   1559 if not (self._backward_hooks or self._backward_pre_hooks or self.
 ↪_forward_hooks or self._forward_pre_hooks
   1560         or _global_backward_pre_hooks or _global_backward_hooks
   1561         or _global_forward_hooks or _global_forward_pre_hooks):
-> 1562     return forward_call(*args, **kwargs)
   1564 try:
   1565     result = None

Cell In[67], line 17, in CNN.forward(self, x)
     16 def forward(self, x):
---> 17     x = F.relu(self.conv1(x))
     18     x = self.pool(x)
     19     x = F.relu(self.conv2(x))
```

```
File ~/miniconda3/lib/python3.10/site-packages/torch/nn/modules/module.py:1553, in Module._wrapped_call_impl(self, *args, **kwargs)
   1551     return self._compiled_call_impl(*args, **kwargs)  # type: ignore[misc]
   1552 else:
-> 1553     return self._call_impl(*args, **kwargs)

File ~/miniconda3/lib/python3.10/site-packages/torch/nn/modules/module.py:1562, in Module._call_impl(self, *args, **kwargs)
   1557 # If we don't have any hooks, we want to skip the rest of the logic in
   1558 # this function, and just call forward.
   1559 if not (self._backward_hooks or self._backward_pre_hooks or self._forward_hooks or self._forward_pre_hooks
   1560         or _global_backward_pre_hooks or _global_backward_hooks
   1561         or _global_forward_hooks or _global_forward_pre_hooks):
-> 1562     return forward_call(*args, **kwargs)
   1564 try:
   1565     result = None

File ~/miniconda3/lib/python3.10/site-packages/torch/nn/modules/conv.py:458, in Conv2d.forward(self, input)
    457 def forward(self, input: Tensor) -> Tensor:
--> 458     return self._conv_forward(input, self.weight, self.bias)

File ~/miniconda3/lib/python3.10/site-packages/torch/nn/modules/conv.py:454, in Conv2d._conv_forward(self, input, weight, bias)
    450 if self.padding_mode != 'zeros':
    451     return F.conv2d(F.pad(input, self._reversed_padding_repeated_twice, mode=self.padding_mode),
    452                     weight, bias, self.stride,
    453                     _pair(0), self.dilation, self.groups)
--> 454 return F.conv2d(input, weight, bias, self.stride,
    455                 self.padding, self.dilation, self.groups)

RuntimeError: Expected 3D (unbatched) or 4D (batched) input to conv2d, but got input of size: [128, 784]
```