train_mobilenet_pneumonia_full

May 6, 2025

```python
[1]: import os
     import datetime
     import torch
     import torchvision.transforms as transforms
     import torchvision.datasets as datasets
     import torch.nn as nn
     import torch.optim as optim
     import matplotlib.pyplot as plt
     import seaborn as sns
     import numpy as np
     from torchvision import models
     from tqdm import tqdm
     import sys
     from sklearn.metrics import confusion_matrix, classification_report
     from collections import Counter
     from PIL import Image
```

```python
[2]: DATA_DIR = os.path.expanduser("~/Zoidberg/data/raw/chest_Xray/test")
     MODEL_PATH = os.path.expanduser("~/Zoidberg/models/mobilenet_pneumonia.pt")
     DOCS_DIR = os.path.expanduser("~/Zoidberg/docs")
     TIMESTAMP = datetime.datetime.now().strftime("%Y%m%d_%H%M%S")
     BATCH_SIZE = 32
     EPOCHS = 10
     LEARNING_RATE = 1e-4
     DEVICE = torch.device("cuda" if torch.cuda.is_available() else "cpu")
```

```python
[3]: data_transforms = transforms.Compose([
         transforms.Resize((224, 224)),
         transforms.ToTensor(),
         transforms.Normalize([0.485, 0.456, 0.406], [0.229, 0.224, 0.225])
     ])

     def load_dataset():
         class_map = {"NORMAL": 0, "bacterial": 1, "viral": 2}
         dataset = datasets.ImageFolder(DATA_DIR, transform=data_transforms)
         new_samples = []
         for path, label in dataset.samples:
             fname = os.path.basename(path).lower()
```

```python
        if "pneumonia" in fname:
            label = class_map["bacterial"] if "bacteria" in fname else
 ↪class_map["viral"]
        else:
            label = class_map["NORMAL"]
        new_samples.append((path, label))
    dataset.samples = new_samples
    dataset.targets = [s[1] for s in new_samples]
    dataset.classes = ["NORMAL", "bacterial", "viral"]
    return dataset

dataset = load_dataset()
train_loader = torch.utils.data.DataLoader(dataset, batch_size=BATCH_SIZE,
 ↪shuffle=True)
val_loader = torch.utils.data.DataLoader(dataset, batch_size=BATCH_SIZE)
```

```python
[4]: train_losses = []
train_accuracies = []

def train():
    model = models.mobilenet_v2(weights=models.MobileNet_V2_Weights.DEFAULT)
    model.classifier[1] = nn.Linear(model.last_channel, 3)
    model = model.to(DEVICE)

    criterion = nn.CrossEntropyLoss()
    optimizer = optim.Adam(model.parameters(), lr=LEARNING_RATE)

    for epoch in range(EPOCHS):
        model.train()
        running_loss = 0.0
        correct = 0
        total = 0
        loop = tqdm(train_loader, desc=f"Epoch {epoch+1}/{EPOCHS}", leave=True,
 ↪file=sys.stdout)
        for inputs, labels in loop:
            inputs, labels = inputs.to(DEVICE), labels.to(DEVICE)
            optimizer.zero_grad()
            outputs = model(inputs)
            loss = criterion(outputs, labels)
            loss.backward()
            optimizer.step()
            running_loss += loss.item()
            _, preds = torch.max(outputs, 1)
            correct += (preds == labels).sum().item()
            total += labels.size(0)
            loop.set_postfix(loss=running_loss / (total / BATCH_SIZE),
 ↪acc=correct / total)
```

```
        train_losses.append(running_loss / len(train_loader))
        train_accuracies.append(correct / total)
        print(f"Epoch {epoch+1} - Loss: {train_losses[-1]:.4f} - Accuracy:␣
 ↪{train_accuracies[-1]:.4f}")

    torch.save(model.state_dict(), MODEL_PATH)
    print(f"Modèle sauvegardé dans : {MODEL_PATH}")
    return model

model = train()
```

```
 Epoch 1/10:    0%|                                                | 0/20 [00:00<?,
?it/s]

 Epoch 1/10:    0%|                      | 0/20 [00:06<?, ?it/s, acc=0.562,
loss=1.01]

 Epoch 1/10:    5%|          | 1/20 [00:06<02:11,  6.93s/it, acc=0.562,
loss=1.01]

 Epoch 1/10:    5%|          | 1/20 [00:10<02:11,  6.93s/it, acc=0.562,
loss=1.02]

 Epoch 1/10:   10%|          | 2/20 [00:10<01:24,  4.67s/it, acc=0.562,
loss=1.02]

 Epoch 1/10:   10%|           | 2/20 [00:12<01:24,  4.67s/it, acc=0.625,
loss=1]

 Epoch 1/10:   15%|           | 3/20 [00:12<01:03,  3.72s/it, acc=0.625,
loss=1]

 Epoch 1/10:   15%|         | 3/20 [00:15<01:03,  3.72s/it, acc=0.695,
loss=0.977]

 Epoch 1/10:   20%|         | 4/20 [00:15<00:53,  3.37s/it, acc=0.695,
loss=0.977]

 Epoch 1/10:   20%|         | 4/20 [00:17<00:53,  3.37s/it, acc=0.756,
loss=0.963]

 Epoch 1/10:   25%|         | 5/20 [00:17<00:45,  3.04s/it, acc=0.756,
loss=0.963]

 Epoch 1/10:   25%|         | 5/20 [00:20<00:45,  3.04s/it, acc=0.797,
loss=0.947]

 Epoch 1/10:   30%|         | 6/20 [00:20<00:40,  2.88s/it, acc=0.797,
loss=0.947]

 Epoch 1/10:   30%|         | 6/20 [00:23<00:40,  2.88s/it, acc=0.817,
loss=0.932]

 Epoch 1/10:   35%|         | 7/20 [00:23<00:36,  2.84s/it, acc=0.817,
loss=0.932]
```

```
Epoch 1/10:  35%|          | 7/20 [00:25<00:36,  2.84s/it, acc=0.84,
loss=0.916]

Epoch 1/10:  40%|          | 8/20 [00:25<00:31,  2.62s/it, acc=0.84,
loss=0.916]

Epoch 1/10:  40%|          | 8/20 [00:28<00:31,  2.62s/it, acc=0.858,
loss=0.901]

Epoch 1/10:  45%|          | 9/20 [00:28<00:29,  2.69s/it, acc=0.858,
loss=0.901]

Epoch 1/10:  45%|          | 9/20 [00:30<00:29,  2.69s/it, acc=0.872,
loss=0.884]

Epoch 1/10:  50%|          | 10/20 [00:30<00:26,  2.60s/it, acc=0.872,
loss=0.884]

Epoch 1/10:  50%|          | 10/20 [00:33<00:26,  2.60s/it, acc=0.884,
loss=0.87]

Epoch 1/10:  55%|          | 11/20 [00:33<00:23,  2.66s/it, acc=0.884,
loss=0.87]

Epoch 1/10:  55%|          | 11/20 [00:35<00:23,  2.66s/it, acc=0.893,
loss=0.858]

Epoch 1/10:  60%|          | 12/20 [00:35<00:20,  2.53s/it, acc=0.893,
loss=0.858]

Epoch 1/10:  60%|          | 12/20 [00:42<00:20,  2.53s/it, acc=0.901,
loss=0.845]

Epoch 1/10:  65%|          | 13/20 [00:42<00:26,  3.78s/it, acc=0.901,
loss=0.845]

Epoch 1/10:  65%|          | 13/20 [00:44<00:26,  3.78s/it, acc=0.908,
loss=0.831]

Epoch 1/10:  70%|          | 14/20 [00:44<00:19,  3.32s/it, acc=0.908,
loss=0.831]

Epoch 1/10:  70%|          | 14/20 [00:47<00:19,  3.32s/it, acc=0.915,
loss=0.818]

Epoch 1/10:  75%|          | 15/20 [00:47<00:15,  3.12s/it, acc=0.915,
loss=0.818]

Epoch 1/10:  75%|          | 15/20 [00:49<00:15,  3.12s/it, acc=0.92,
loss=0.805]

Epoch 1/10:  80%|          | 16/20 [00:49<00:11,  2.82s/it, acc=0.92,
loss=0.805]

Epoch 1/10:  80%|          | 16/20 [00:52<00:11,  2.82s/it, acc=0.925,
loss=0.792]
```

```
 Epoch 1/10:   85%|        | 17/20 [00:52<00:08,  2.88s/it, acc=0.925,
loss=0.792]

 Epoch 1/10:   85%|        | 17/20 [00:54<00:08,  2.88s/it, acc=0.929,
loss=0.779]

 Epoch 1/10:   90%|        | 18/20 [00:54<00:05,  2.64s/it, acc=0.929,
loss=0.779]

 Epoch 1/10:   90%|        | 18/20 [00:56<00:05,  2.64s/it, acc=0.933,
loss=0.766]

 Epoch 1/10:   95%|        | 19/20 [00:56<00:02,  2.60s/it, acc=0.933,
loss=0.766]

 Epoch 1/10:   95%|        | 19/20 [00:57<00:02,  2.60s/it, acc=0.934,
loss=0.773]

 Epoch 1/10:  100%|        | 20/20 [00:57<00:00,  2.09s/it, acc=0.934,
loss=0.773]

 Epoch 1/10:  100%|        | 20/20 [00:57<00:00,  2.89s/it, acc=0.934,
loss=0.773]


Epoch 1 - Loss: 0.7536 - Accuracy: 0.9343

 Epoch 2/10:   0%|                              | 0/20 [00:00<?,
?it/s]

 Epoch 2/10:   0%|                   | 0/20 [00:02<?, ?it/s, acc=1,
loss=0.475]

 Epoch 2/10:   5%|           | 1/20 [00:02<00:39,  2.08s/it, acc=1,
loss=0.475]

 Epoch 2/10:   5%|           | 1/20 [00:04<00:39,  2.08s/it, acc=1,
loss=0.466]

 Epoch 2/10:  10%|           | 2/20 [00:04<00:44,  2.46s/it, acc=1,
loss=0.466]

 Epoch 2/10:  10%|           | 2/20 [00:06<00:44,  2.46s/it, acc=1,
loss=0.458]

 Epoch 2/10:  15%|           | 3/20 [00:06<00:39,  2.32s/it, acc=1,
loss=0.458]

 Epoch 2/10:  15%|           | 3/20 [00:09<00:39,  2.32s/it, acc=1,
loss=0.448]

 Epoch 2/10:  20%|           | 4/20 [00:09<00:38,  2.41s/it, acc=1,
loss=0.448]

 Epoch 2/10:  20%|           | 4/20 [00:11<00:38,  2.41s/it, acc=1,
loss=0.437]
```

```
Epoch 2/10:  25%|              | 5/20 [00:11<00:33,  2.27s/it, acc=1,
loss=0.437]
 Epoch 2/10:  25%|              | 5/20 [00:15<00:33,  2.27s/it, acc=1,
loss=0.428]
 Epoch 2/10:  30%|              | 6/20 [00:15<00:38,  2.78s/it, acc=1,
loss=0.428]
 Epoch 2/10:  30%|              | 6/20 [00:19<00:38,  2.78s/it, acc=1,
loss=0.42]
 Epoch 2/10:  35%|              | 7/20 [00:19<00:44,  3.41s/it, acc=1,
loss=0.42]
 Epoch 2/10:  35%|              | 7/20 [00:21<00:44,  3.41s/it, acc=1,
loss=0.411]
 Epoch 2/10:  40%|              | 8/20 [00:21<00:35,  2.94s/it, acc=1,
loss=0.411]
 Epoch 2/10:  40%|              | 8/20 [00:24<00:35,  2.94s/it, acc=1,
loss=0.405]
 Epoch 2/10:  45%|              | 9/20 [00:24<00:31,  2.88s/it, acc=1,
loss=0.405]
 Epoch 2/10:  45%|              | 9/20 [00:26<00:31,  2.88s/it, acc=1,
loss=0.397]
 Epoch 2/10:  50%|              | 10/20 [00:26<00:27,  2.70s/it, acc=1,
loss=0.397]
 Epoch 2/10:  50%|              | 10/20 [00:29<00:27,  2.70s/it, acc=1,
loss=0.389]
 Epoch 2/10:  55%|              | 11/20 [00:29<00:23,  2.59s/it, acc=1,
loss=0.389]
 Epoch 2/10:  55%|              | 11/20 [00:31<00:23,  2.59s/it, acc=1,
loss=0.382]
 Epoch 2/10:  60%|              | 12/20 [00:31<00:19,  2.40s/it, acc=1,
loss=0.382]
 Epoch 2/10:  60%|              | 12/20 [00:33<00:19,  2.40s/it, acc=1,
loss=0.375]
 Epoch 2/10:  65%|              | 13/20 [00:33<00:17,  2.44s/it, acc=1,
loss=0.375]
 Epoch 2/10:  65%|              | 13/20 [00:36<00:17,  2.44s/it, acc=1,
loss=0.368]
 Epoch 2/10:  70%|              | 14/20 [00:36<00:14,  2.40s/it, acc=1,
loss=0.368]
```

```
Epoch 2/10:  70%|            | 14/20 [00:38<00:14,  2.40s/it, acc=1,
loss=0.362]
 Epoch 2/10:  75%|            | 15/20 [00:38<00:12,  2.48s/it, acc=1,
loss=0.362]
 Epoch 2/10:  75%|            | 15/20 [00:40<00:12,  2.48s/it, acc=1,
loss=0.355]
 Epoch 2/10:  80%|            | 16/20 [00:40<00:09,  2.39s/it, acc=1,
loss=0.355]
 Epoch 2/10:  80%|            | 16/20 [00:43<00:09,  2.39s/it, acc=1,
loss=0.349]
 Epoch 2/10:  85%|            | 17/20 [00:43<00:07,  2.47s/it, acc=1,
loss=0.349]
 Epoch 2/10:  85%|            | 17/20 [00:45<00:07,  2.47s/it, acc=1,
loss=0.342]
 Epoch 2/10:  90%|            | 18/20 [00:45<00:04,  2.40s/it, acc=1,
loss=0.342]
 Epoch 2/10:  90%|            | 18/20 [00:48<00:04,  2.40s/it, acc=1,
loss=0.335]
 Epoch 2/10:  95%|            | 19/20 [00:48<00:02,  2.48s/it, acc=1,
loss=0.335]
 Epoch 2/10:  95%|            | 19/20 [00:53<00:02,  2.48s/it, acc=1,
loss=0.338]
 Epoch 2/10: 100%|            | 20/20 [00:53<00:00,  3.18s/it, acc=1,
loss=0.338]
 Epoch 2/10: 100%|            | 20/20 [00:53<00:00,  2.67s/it, acc=1,
loss=0.338]

Epoch 2 - Loss: 0.3291 - Accuracy: 1.0000
 Epoch 3/10:   0%|                              | 0/20 [00:00<?,
?it/s]
 Epoch 3/10:   0%|                | 0/20 [00:02<?, ?it/s, acc=1,
loss=0.199]
 Epoch 3/10:   5%|            | 1/20 [00:02<00:44,  2.34s/it, acc=1,
loss=0.199]
 Epoch 3/10:   5%|            | 1/20 [00:04<00:44,  2.34s/it, acc=1,
loss=0.191]
 Epoch 3/10:  10%|            | 2/20 [00:04<00:43,  2.39s/it, acc=1,
loss=0.191]
```

```
Epoch 3/10:   10%|                    | 2/20 [00:06<00:43,  2.39s/it, acc=1,
loss=0.19]

Epoch 3/10:   15%|                    | 3/20 [00:06<00:38,  2.29s/it, acc=1,
loss=0.19]

Epoch 3/10:   15%|                    | 3/20 [00:09<00:38,  2.29s/it, acc=1,
loss=0.189]

Epoch 3/10:   20%|                   | 4/20 [00:09<00:36,  2.31s/it, acc=1,
loss=0.189]

Epoch 3/10:   20%|                   | 4/20 [00:11<00:36,  2.31s/it, acc=1,
loss=0.184]

Epoch 3/10:   25%|                  | 5/20 [00:11<00:34,  2.33s/it, acc=1,
loss=0.184]

Epoch 3/10:   25%|                  | 5/20 [00:14<00:34,  2.33s/it, acc=1,
loss=0.181]

Epoch 3/10:   30%|                 | 6/20 [00:14<00:33,  2.41s/it, acc=1,
loss=0.181]

Epoch 3/10:   30%|                 | 6/20 [00:16<00:33,  2.41s/it, acc=1,
loss=0.177]

Epoch 3/10:   35%|                | 7/20 [00:16<00:30,  2.33s/it, acc=1,
loss=0.177]

Epoch 3/10:   35%|                | 7/20 [00:19<00:30,  2.33s/it, acc=1,
loss=0.174]

Epoch 3/10:   40%|               | 8/20 [00:19<00:29,  2.43s/it, acc=1,
loss=0.174]

Epoch 3/10:   40%|               | 8/20 [00:21<00:29,  2.43s/it, acc=1,
loss=0.171]

Epoch 3/10:   45%|              | 9/20 [00:21<00:25,  2.31s/it, acc=1,
loss=0.171]

Epoch 3/10:   45%|              | 9/20 [00:23<00:25,  2.31s/it, acc=1,
loss=0.168]

Epoch 3/10:   50%|             | 10/20 [00:23<00:23,  2.36s/it, acc=1,
loss=0.168]

Epoch 3/10:   50%|             | 10/20 [00:26<00:23,  2.36s/it, acc=1,
loss=0.165]

Epoch 3/10:   55%|            | 11/20 [00:26<00:21,  2.43s/it, acc=1,
loss=0.165]

Epoch 3/10:   55%|            | 11/20 [00:28<00:21,  2.43s/it, acc=1,
loss=0.162]
```

```
Epoch 3/10:   60%|          | 12/20 [00:28<00:18,  2.34s/it, acc=1,
loss=0.162]
 Epoch 3/10:   60%|           | 12/20 [00:32<00:18,  2.34s/it, acc=1,
loss=0.16]
 Epoch 3/10:   65%|          | 13/20 [00:32<00:19,  2.82s/it, acc=1,
loss=0.16]
 Epoch 3/10:   65%|          | 13/20 [00:36<00:19,  2.82s/it, acc=1,
loss=0.157]
 Epoch 3/10:   70%|          | 14/20 [00:36<00:19,  3.17s/it, acc=1,
loss=0.157]
 Epoch 3/10:   70%|          | 14/20 [00:38<00:19,  3.17s/it, acc=1,
loss=0.155]
 Epoch 3/10:   75%|          | 15/20 [00:38<00:14,  3.00s/it, acc=1,
loss=0.155]
 Epoch 3/10:   75%|          | 15/20 [00:40<00:14,  3.00s/it, acc=1,
loss=0.152]
 Epoch 3/10:   80%|          | 16/20 [00:40<00:10,  2.71s/it, acc=1,
loss=0.152]
 Epoch 3/10:   80%|          | 16/20 [00:43<00:10,  2.71s/it, acc=1,
loss=0.149]
 Epoch 3/10:   85%|          | 17/20 [00:43<00:07,  2.61s/it, acc=1,
loss=0.149]
 Epoch 3/10:   85%|          | 17/20 [00:45<00:07,  2.61s/it, acc=1,
loss=0.147]
 Epoch 3/10:   90%|          | 18/20 [00:45<00:05,  2.52s/it, acc=1,
loss=0.147]
 Epoch 3/10:   90%|          | 18/20 [00:47<00:05,  2.52s/it, acc=1,
loss=0.145]
 Epoch 3/10:   95%|          | 19/20 [00:47<00:02,  2.48s/it, acc=1,
loss=0.145]
 Epoch 3/10:   95%|          | 19/20 [00:48<00:02,  2.48s/it, acc=1,
loss=0.146]
 Epoch 3/10:  100%|          | 20/20 [00:48<00:00,  2.01s/it, acc=1,
loss=0.146]
 Epoch 3/10:  100%|          | 20/20 [00:48<00:00,  2.44s/it, acc=1,
loss=0.146]

Epoch 3 - Loss: 0.1421 - Accuracy: 1.0000
```

```
Epoch 4/10:    0%|                                              | 0/20 [00:00<?,
?it/s]
Epoch 4/10:    0%|                      | 0/20 [00:02<?, ?it/s, acc=1,
loss=0.0949]
Epoch 4/10:    5%|            | 1/20 [00:02<00:42,  2.22s/it, acc=1,
loss=0.0949]
Epoch 4/10:    5%|            | 1/20 [00:04<00:42,  2.22s/it, acc=1,
loss=0.091]
Epoch 4/10:   10%|            | 2/20 [00:04<00:40,  2.28s/it, acc=1,
loss=0.091]
Epoch 4/10:   10%|            | 2/20 [00:07<00:40,  2.28s/it, acc=1,
loss=0.0904]
Epoch 4/10:   15%|            | 3/20 [00:07<00:41,  2.44s/it, acc=1,
loss=0.0904]
Epoch 4/10:   15%|            | 3/20 [00:09<00:41,  2.44s/it, acc=1,
loss=0.088]
Epoch 4/10:   20%|            | 4/20 [00:09<00:38,  2.42s/it, acc=1,
loss=0.088]
Epoch 4/10:   20%|            | 4/20 [00:11<00:38,  2.42s/it, acc=1,
loss=0.0866]
Epoch 4/10:   25%|            | 5/20 [00:11<00:35,  2.40s/it, acc=1,
loss=0.0866]
Epoch 4/10:   25%|            | 5/20 [00:14<00:35,  2.40s/it, acc=1,
loss=0.0843]
Epoch 4/10:   30%|            | 6/20 [00:14<00:33,  2.40s/it, acc=1,
loss=0.0843]
Epoch 4/10:   30%|            | 6/20 [00:17<00:33,  2.40s/it, acc=1,
loss=0.0832]
Epoch 4/10:   35%|            | 7/20 [00:17<00:34,  2.64s/it, acc=1,
loss=0.0832]
Epoch 4/10:   35%|            | 7/20 [00:22<00:34,  2.64s/it, acc=1,
loss=0.0821]
Epoch 4/10:   40%|            | 8/20 [00:22<00:40,  3.34s/it, acc=1,
loss=0.0821]
Epoch 4/10:   40%|            | 8/20 [00:24<00:40,  3.34s/it, acc=1,
loss=0.0812]
Epoch 4/10:   45%|            | 9/20 [00:24<00:34,  3.14s/it, acc=1,
loss=0.0812]
```

```
Epoch 4/10:  45%|          | 9/20 [00:27<00:34,  3.14s/it, acc=1,
loss=0.0803]
 Epoch 4/10:  50%|          | 10/20 [00:27<00:28,  2.83s/it, acc=1,
loss=0.0803]
 Epoch 4/10:  50%|          | 10/20 [00:29<00:28,  2.83s/it, acc=1,
loss=0.0792]
 Epoch 4/10:  55%|          | 11/20 [00:29<00:25,  2.79s/it, acc=1,
loss=0.0792]
 Epoch 4/10:  55%|          | 11/20 [00:31<00:25,  2.79s/it, acc=1,
loss=0.0777]
 Epoch 4/10:  60%|          | 12/20 [00:31<00:20,  2.58s/it, acc=1,
loss=0.0777]
 Epoch 4/10:  60%|          | 12/20 [00:34<00:20,  2.58s/it, acc=1,
loss=0.0765]
 Epoch 4/10:  65%|          | 13/20 [00:34<00:18,  2.67s/it, acc=1,
loss=0.0765]
 Epoch 4/10:  65%|          | 13/20 [00:37<00:18,  2.67s/it, acc=1,
loss=0.0757]
 Epoch 4/10:  70%|          | 14/20 [00:37<00:15,  2.55s/it, acc=1,
loss=0.0757]
 Epoch 4/10:  70%|          | 14/20 [00:39<00:15,  2.55s/it, acc=1,
loss=0.0744]
 Epoch 4/10:  75%|          | 15/20 [00:39<00:12,  2.57s/it, acc=1,
loss=0.0744]
 Epoch 4/10:  75%|          | 15/20 [00:41<00:12,  2.57s/it, acc=1,
loss=0.0734]
 Epoch 4/10:  80%|          | 16/20 [00:41<00:09,  2.46s/it, acc=1,
loss=0.0734]
 Epoch 4/10:  80%|          | 16/20 [00:45<00:09,  2.46s/it, acc=1,
loss=0.0725]
 Epoch 4/10:  85%|          | 17/20 [00:45<00:08,  2.73s/it, acc=1,
loss=0.0725]
 Epoch 4/10:  85%|          | 17/20 [00:47<00:08,  2.73s/it, acc=1,
loss=0.0719]
 Epoch 4/10:  90%|          | 18/20 [00:47<00:05,  2.59s/it, acc=1,
loss=0.0719]
 Epoch 4/10:  90%|          | 18/20 [00:49<00:05,  2.59s/it, acc=1,
loss=0.0711]
```

```
Epoch 4/10:   95%|         | 19/20 [00:49<00:02,  2.54s/it, acc=1,
loss=0.0711]
 Epoch 4/10:   95%|         | 19/20 [00:50<00:02,  2.54s/it, acc=1,
loss=0.0719]
 Epoch 4/10:  100%|         | 20/20 [00:50<00:00,  2.03s/it, acc=1,
loss=0.0719]
 Epoch 4/10:  100%|         | 20/20 [00:50<00:00,  2.54s/it, acc=1,
loss=0.0719]


Epoch 4 - Loss: 0.0701 - Accuracy: 1.0000
 Epoch 5/10:    0%|                               | 0/20 [00:00<?,
?it/s]
 Epoch 5/10:    0%|                     | 0/20 [00:06<?, ?it/s, acc=1,
loss=0.05]
 Epoch 5/10:    5%|            | 1/20 [00:06<01:57,  6.16s/it, acc=1,
loss=0.05]
 Epoch 5/10:    5%|            | 1/20 [00:08<01:57,  6.16s/it, acc=1,
loss=0.0474]
 Epoch 5/10:   10%|           | 2/20 [00:08<01:13,  4.08s/it, acc=1,
loss=0.0474]
 Epoch 5/10:   10%|           | 2/20 [00:10<01:13,  4.08s/it, acc=1,
loss=0.0464]
 Epoch 5/10:   15%|           | 3/20 [00:10<00:53,  3.13s/it, acc=1,
loss=0.0464]
 Epoch 5/10:   15%|           | 3/20 [00:13<00:53,  3.13s/it, acc=1,
loss=0.0454]
 Epoch 5/10:   20%|           | 4/20 [00:13<00:47,  2.97s/it, acc=1,
loss=0.0454]
 Epoch 5/10:   20%|           | 4/20 [00:15<00:47,  2.97s/it, acc=1,
loss=0.0451]
 Epoch 5/10:   25%|           | 5/20 [00:15<00:41,  2.75s/it, acc=1,
loss=0.0451]
 Epoch 5/10:   25%|           | 5/20 [00:18<00:41,  2.75s/it, acc=1,
loss=0.0446]
 Epoch 5/10:   30%|           | 6/20 [00:18<00:38,  2.75s/it, acc=1,
loss=0.0446]
 Epoch 5/10:   30%|           | 6/20 [00:21<00:38,  2.75s/it, acc=1,
loss=0.0438]
```

```
Epoch 5/10:  35%|              | 7/20 [00:21<00:35,  2.70s/it, acc=1,
loss=0.0438]
 Epoch 5/10:  35%|              | 7/20 [00:23<00:35,  2.70s/it, acc=1,
loss=0.0434]
 Epoch 5/10:  40%|              | 8/20 [00:23<00:31,  2.61s/it, acc=1,
loss=0.0434]
 Epoch 5/10:  40%|              | 8/20 [00:25<00:31,  2.61s/it, acc=1,
loss=0.0428]
 Epoch 5/10:  45%|              | 9/20 [00:25<00:27,  2.49s/it, acc=1,
loss=0.0428]
 Epoch 5/10:  45%|              | 9/20 [00:28<00:27,  2.49s/it, acc=1,
loss=0.0424]
 Epoch 5/10:  50%|              | 10/20 [00:28<00:25,  2.58s/it, acc=1,
loss=0.0424]
 Epoch 5/10:  50%|              | 10/20 [00:30<00:25,  2.58s/it, acc=1,
loss=0.0419]
 Epoch 5/10:  55%|              | 11/20 [00:30<00:21,  2.41s/it, acc=1,
loss=0.0419]
 Epoch 5/10:  55%|              | 11/20 [00:33<00:21,  2.41s/it, acc=1,
loss=0.0417]
 Epoch 5/10:  60%|              | 12/20 [00:33<00:20,  2.50s/it, acc=1,
loss=0.0417]
 Epoch 5/10:  60%|              | 12/20 [00:36<00:20,  2.50s/it, acc=1,
loss=0.0413]
 Epoch 5/10:  65%|              | 13/20 [00:36<00:18,  2.59s/it, acc=1,
loss=0.0413]
 Epoch 5/10:  65%|              | 13/20 [00:42<00:18,  2.59s/it, acc=1,
loss=0.0409]
 Epoch 5/10:  70%|              | 14/20 [00:42<00:21,  3.59s/it, acc=1,
loss=0.0409]
 Epoch 5/10:  70%|              | 14/20 [00:44<00:21,  3.59s/it, acc=1,
loss=0.0405]
 Epoch 5/10:  75%|              | 15/20 [00:44<00:15,  3.19s/it, acc=1,
loss=0.0405]
 Epoch 5/10:  75%|              | 15/20 [00:46<00:15,  3.19s/it, acc=1,
loss=0.04]
 Epoch 5/10:  80%|              | 16/20 [00:46<00:11,  2.99s/it, acc=1,
loss=0.04]
```

```
Epoch 5/10:   80%|          | 16/20 [00:49<00:11,  2.99s/it, acc=1,
loss=0.0395]
 Epoch 5/10:   85%|          | 17/20 [00:49<00:08,  2.80s/it, acc=1,
loss=0.0395]
 Epoch 5/10:   85%|          | 17/20 [00:52<00:08,  2.80s/it, acc=1,
loss=0.0391]
 Epoch 5/10:   90%|          | 18/20 [00:52<00:05,  2.86s/it, acc=1,
loss=0.0391]
 Epoch 5/10:   90%|          | 18/20 [00:54<00:05,  2.86s/it, acc=1,
loss=0.0386]
 Epoch 5/10:   95%|          | 19/20 [00:54<00:02,  2.62s/it, acc=1,
loss=0.0386]
 Epoch 5/10:   95%|          | 19/20 [00:55<00:02,  2.62s/it, acc=1,
loss=0.0391]
 Epoch 5/10:  100%|          | 20/20 [00:55<00:00,  2.08s/it, acc=1,
loss=0.0391]
 Epoch 5/10:  100%|          | 20/20 [00:55<00:00,  2.76s/it, acc=1,
loss=0.0391]

Epoch 5 - Loss: 0.0382 - Accuracy: 1.0000
 Epoch 6/10:    0%|                              | 0/20 [00:00<?,
?it/s]
 Epoch 6/10:    0%|                    | 0/20 [00:02<?, ?it/s, acc=1,
loss=0.0304]
 Epoch 6/10:    5%|          | 1/20 [00:02<00:48,  2.56s/it, acc=1,
loss=0.0304]
 Epoch 6/10:    5%|          | 1/20 [00:04<00:48,  2.56s/it, acc=1,
loss=0.0305]
 Epoch 6/10:   10%|          | 2/20 [00:04<00:42,  2.38s/it, acc=1,
loss=0.0305]
 Epoch 6/10:   10%|          | 2/20 [00:07<00:42,  2.38s/it, acc=1,
loss=0.0297]
 Epoch 6/10:   15%|          | 3/20 [00:07<00:41,  2.45s/it, acc=1,
loss=0.0297]
 Epoch 6/10:   15%|          | 3/20 [00:09<00:41,  2.45s/it, acc=1,
loss=0.0292]
 Epoch 6/10:   20%|          | 4/20 [00:09<00:37,  2.36s/it, acc=1,
loss=0.0292]
```

```
Epoch 6/10:  20%|            | 4/20 [00:12<00:37,  2.36s/it, acc=1,
loss=0.0284]
 Epoch 6/10:  25%|            | 5/20 [00:12<00:35,  2.39s/it, acc=1,
loss=0.0284]
 Epoch 6/10:  25%|            | 5/20 [00:13<00:35,  2.39s/it, acc=1,
loss=0.0281]
 Epoch 6/10:  30%|            | 6/20 [00:13<00:31,  2.25s/it, acc=1,
loss=0.0281]
 Epoch 6/10:  30%|            | 6/20 [00:19<00:31,  2.25s/it, acc=1,
loss=0.0282]
 Epoch 6/10:  35%|            | 7/20 [00:19<00:41,  3.21s/it, acc=1,
loss=0.0282]
 Epoch 6/10:  35%|            | 7/20 [00:22<00:41,  3.21s/it, acc=1,
loss=0.0279]
 Epoch 6/10:  40%|            | 8/20 [00:22<00:38,  3.23s/it, acc=1,
loss=0.0279]
 Epoch 6/10:  40%|            | 8/20 [00:24<00:38,  3.23s/it, acc=1,
loss=0.0278]
 Epoch 6/10:  45%|            | 9/20 [00:24<00:32,  2.97s/it, acc=1,
loss=0.0278]
 Epoch 6/10:  45%|            | 9/20 [00:27<00:32,  2.97s/it, acc=1,
loss=0.0275]
 Epoch 6/10:  50%|            | 10/20 [00:27<00:28,  2.81s/it, acc=1,
loss=0.0275]
 Epoch 6/10:  50%|            | 10/20 [00:29<00:28,  2.81s/it, acc=1,
loss=0.0272]
 Epoch 6/10:  55%|            | 11/20 [00:29<00:24,  2.67s/it, acc=1,
loss=0.0272]
 Epoch 6/10:  55%|            | 11/20 [00:32<00:24,  2.67s/it, acc=1,
loss=0.0269]
 Epoch 6/10:  60%|            | 12/20 [00:32<00:20,  2.61s/it, acc=1,
loss=0.0269]
 Epoch 6/10:  60%|            | 12/20 [00:34<00:20,  2.61s/it, acc=1,
loss=0.0267]
 Epoch 6/10:  65%|            | 13/20 [00:34<00:17,  2.53s/it, acc=1,
loss=0.0267]
 Epoch 6/10:  65%|            | 13/20 [00:36<00:17,  2.53s/it, acc=1,
loss=0.0265]
```

```
Epoch 6/10:   70%|         | 14/20 [00:36<00:14,  2.46s/it, acc=1,
loss=0.0265]
Epoch 6/10:   70%|         | 14/20 [00:39<00:14,  2.46s/it, acc=1,
loss=0.0264]
Epoch 6/10:   75%|         | 15/20 [00:39<00:12,  2.45s/it, acc=1,
loss=0.0264]
Epoch 6/10:   75%|         | 15/20 [00:41<00:12,  2.45s/it, acc=1,
loss=0.0262]
Epoch 6/10:   80%|         | 16/20 [00:41<00:10,  2.51s/it, acc=1,
loss=0.0262]
Epoch 6/10:   80%|         | 16/20 [00:44<00:10,  2.51s/it, acc=1,
loss=0.0259]
Epoch 6/10:   85%|         | 17/20 [00:44<00:07,  2.42s/it, acc=1,
loss=0.0259]
Epoch 6/10:   85%|         | 17/20 [00:46<00:07,  2.42s/it, acc=1,
loss=0.0256]
Epoch 6/10:   90%|         | 18/20 [00:46<00:04,  2.43s/it, acc=1,
loss=0.0256]
Epoch 6/10:   90%|         | 18/20 [00:48<00:04,  2.43s/it, acc=1,
loss=0.0254]
Epoch 6/10:   95%|         | 19/20 [00:48<00:02,  2.37s/it, acc=1,
loss=0.0254]
Epoch 6/10:   95%|         | 19/20 [00:50<00:02,  2.37s/it, acc=1,
loss=0.0258]
Epoch 6/10:  100%|         | 20/20 [00:50<00:00,  2.08s/it, acc=1,
loss=0.0258]
Epoch 6/10:  100%|         | 20/20 [00:50<00:00,  2.51s/it, acc=1,
loss=0.0258]

Epoch 6 - Loss: 0.0251 - Accuracy: 1.0000
Epoch 7/10:    0%|                            | 0/20 [00:00<?,
?it/s]
Epoch 7/10:    0%|                  | 0/20 [00:06<?, ?it/s, acc=1,
loss=0.0194]
Epoch 7/10:    5%|         | 1/20 [00:06<01:58,  6.25s/it, acc=1,
loss=0.0194]
Epoch 7/10:    5%|         | 1/20 [00:08<01:58,  6.25s/it, acc=1,
loss=0.0203]
```

```
Epoch 7/10:    10%|              | 2/20 [00:08<01:09,  3.85s/it, acc=1,
loss=0.0203]

Epoch 7/10:    10%|              | 2/20 [00:10<01:09,  3.85s/it, acc=1,
loss=0.0196]

Epoch 7/10:    15%|              | 3/20 [00:10<00:53,  3.14s/it, acc=1,
loss=0.0196]

Epoch 7/10:    15%|              | 3/20 [00:12<00:53,  3.14s/it, acc=1,
loss=0.0193]

Epoch 7/10:    20%|             | 4/20 [00:12<00:43,  2.70s/it, acc=1,
loss=0.0193]

Epoch 7/10:    20%|             | 4/20 [00:15<00:43,  2.70s/it, acc=1,
loss=0.0193]

Epoch 7/10:    25%|             | 5/20 [00:15<00:42,  2.82s/it, acc=1,
loss=0.0193]

Epoch 7/10:    25%|             | 5/20 [00:17<00:42,  2.82s/it, acc=1,
loss=0.0193]

Epoch 7/10:    30%|            | 6/20 [00:17<00:36,  2.58s/it, acc=1,
loss=0.0193]

Epoch 7/10:    30%|            | 6/20 [00:20<00:36,  2.58s/it, acc=1,
loss=0.0191]

Epoch 7/10:    35%|            | 7/20 [00:20<00:33,  2.61s/it, acc=1,
loss=0.0191]

Epoch 7/10:    35%|            | 7/20 [00:22<00:33,  2.61s/it, acc=1,
loss=0.019]

Epoch 7/10:    40%|           | 8/20 [00:22<00:29,  2.45s/it, acc=1,
loss=0.019]

Epoch 7/10:    40%|           | 8/20 [00:25<00:29,  2.45s/it, acc=1,
loss=0.019]

Epoch 7/10:    45%|           | 9/20 [00:25<00:27,  2.48s/it, acc=1,
loss=0.019]

Epoch 7/10:    45%|          | 9/20 [00:27<00:27,  2.48s/it, acc=1,
loss=0.0189]

Epoch 7/10:    50%|          | 10/20 [00:27<00:23,  2.33s/it, acc=1,
loss=0.0189]

Epoch 7/10:    50%|          | 10/20 [00:29<00:23,  2.33s/it, acc=1,
loss=0.0187]

Epoch 7/10:    55%|         | 11/20 [00:29<00:21,  2.42s/it, acc=1,
loss=0.0187]
```

```
Epoch 7/10:   55%|          | 11/20 [00:32<00:21,  2.42s/it, acc=1,
loss=0.0186]
 Epoch 7/10:   60%|          | 12/20 [00:32<00:18,  2.37s/it, acc=1,
loss=0.0186]
 Epoch 7/10:   60%|          | 12/20 [00:34<00:18,  2.37s/it, acc=1,
loss=0.0185]
 Epoch 7/10:   65%|          | 13/20 [00:34<00:16,  2.42s/it, acc=1,
loss=0.0185]
 Epoch 7/10:   65%|          | 13/20 [00:40<00:16,  2.42s/it, acc=1,
loss=0.0184]
 Epoch 7/10:   70%|          | 14/20 [00:40<00:21,  3.58s/it, acc=1,
loss=0.0184]
 Epoch 7/10:   70%|          | 14/20 [00:42<00:21,  3.58s/it, acc=1,
loss=0.0182]
 Epoch 7/10:   75%|          | 15/20 [00:42<00:15,  3.10s/it, acc=1,
loss=0.0182]
 Epoch 7/10:   75%|          | 15/20 [00:45<00:15,  3.10s/it, acc=1,
loss=0.018]
 Epoch 7/10:   80%|          | 16/20 [00:45<00:11,  2.96s/it, acc=1,
loss=0.018]
 Epoch 7/10:   80%|          | 16/20 [00:47<00:11,  2.96s/it, acc=1,
loss=0.0178]
 Epoch 7/10:   85%|          | 17/20 [00:47<00:08,  2.69s/it, acc=1,
loss=0.0178]
 Epoch 7/10:   85%|          | 17/20 [00:50<00:08,  2.69s/it, acc=1,
loss=0.0177]
 Epoch 7/10:   90%|          | 18/20 [00:50<00:05,  2.71s/it, acc=1,
loss=0.0177]
 Epoch 7/10:   90%|          | 18/20 [00:52<00:05,  2.71s/it, acc=1,
loss=0.0176]
 Epoch 7/10:   95%|          | 19/20 [00:52<00:02,  2.60s/it, acc=1,
loss=0.0176]
 Epoch 7/10:   95%|          | 19/20 [00:53<00:02,  2.60s/it, acc=1,
loss=0.0179]
 Epoch 7/10:  100%|          | 20/20 [00:53<00:00,  2.17s/it, acc=1,
loss=0.0179]
 Epoch 7/10:  100%|          | 20/20 [00:53<00:00,  2.69s/it, acc=1,
loss=0.0179]
```

```
Epoch 7 - Loss: 0.0174 - Accuracy: 1.0000
 Epoch 8/10:   0%|                                        | 0/20 [00:00<?,
?it/s]
 Epoch 8/10:   0%|                       | 0/20 [00:01<?, ?it/s, acc=1,
loss=0.0144]
 Epoch 8/10:   5%|            | 1/20 [00:01<00:36,  1.90s/it, acc=1,
loss=0.0144]
 Epoch 8/10:   5%|            | 1/20 [00:04<00:36,  1.90s/it, acc=1,
loss=0.0145]
 Epoch 8/10:  10%|            | 2/20 [00:04<00:42,  2.36s/it, acc=1,
loss=0.0145]
 Epoch 8/10:  10%|            | 2/20 [00:06<00:42,  2.36s/it, acc=1,
loss=0.0144]
 Epoch 8/10:  15%|            | 3/20 [00:06<00:37,  2.23s/it, acc=1,
loss=0.0144]
 Epoch 8/10:  15%|            | 3/20 [00:08<00:37,  2.23s/it, acc=1,
loss=0.0144]
 Epoch 8/10:  20%|            | 4/20 [00:08<00:35,  2.22s/it, acc=1,
loss=0.0144]
 Epoch 8/10:  20%|            | 4/20 [00:11<00:35,  2.22s/it, acc=1,
loss=0.0143]
 Epoch 8/10:  25%|            | 5/20 [00:11<00:34,  2.31s/it, acc=1,
loss=0.0143]
 Epoch 8/10:  25%|            | 5/20 [00:13<00:34,  2.31s/it, acc=1,
loss=0.0142]
 Epoch 8/10:  30%|            | 6/20 [00:13<00:32,  2.29s/it, acc=1,
loss=0.0142]
 Epoch 8/10:  30%|            | 6/20 [00:15<00:32,  2.29s/it, acc=1,
loss=0.0142]
 Epoch 8/10:  35%|            | 7/20 [00:15<00:29,  2.30s/it, acc=1,
loss=0.0142]
 Epoch 8/10:  35%|            | 7/20 [00:21<00:29,  2.30s/it, acc=1,
loss=0.0142]
 Epoch 8/10:  40%|            | 8/20 [00:21<00:41,  3.50s/it, acc=1,
loss=0.0142]
 Epoch 8/10:  40%|            | 8/20 [00:24<00:41,  3.50s/it, acc=1,
loss=0.0141]
```

```
Epoch 8/10:  45%|              | 9/20 [00:24<00:35,  3.22s/it, acc=1,
loss=0.0141]
 Epoch 8/10:  45%|               | 9/20 [00:26<00:35,  3.22s/it, acc=1,
loss=0.014]
 Epoch 8/10:  50%|              | 10/20 [00:26<00:28,  2.86s/it, acc=1,
loss=0.014]
 Epoch 8/10:  50%|              | 10/20 [00:29<00:28,  2.86s/it, acc=1,
loss=0.0139]
 Epoch 8/10:  55%|              | 11/20 [00:29<00:24,  2.74s/it, acc=1,
loss=0.0139]
 Epoch 8/10:  55%|              | 11/20 [00:30<00:24,  2.74s/it, acc=1,
loss=0.0137]
 Epoch 8/10:  60%|             | 12/20 [00:30<00:19,  2.47s/it, acc=1,
loss=0.0137]
 Epoch 8/10:  60%|             | 12/20 [00:33<00:19,  2.47s/it, acc=1,
loss=0.0137]
 Epoch 8/10:  65%|             | 13/20 [00:33<00:16,  2.42s/it, acc=1,
loss=0.0137]
 Epoch 8/10:  65%|             | 13/20 [00:35<00:16,  2.42s/it, acc=1,
loss=0.0137]
 Epoch 8/10:  70%|             | 14/20 [00:35<00:14,  2.42s/it, acc=1,
loss=0.0137]
 Epoch 8/10:  70%|             | 14/20 [00:38<00:14,  2.42s/it, acc=1,
loss=0.0136]
 Epoch 8/10:  75%|            | 15/20 [00:38<00:12,  2.52s/it, acc=1,
loss=0.0136]
 Epoch 8/10:  75%|            | 15/20 [00:40<00:12,  2.52s/it, acc=1,
loss=0.0135]
 Epoch 8/10:  80%|            | 16/20 [00:40<00:09,  2.46s/it, acc=1,
loss=0.0135]
 Epoch 8/10:  80%|            | 16/20 [00:43<00:09,  2.46s/it, acc=1,
loss=0.0135]
 Epoch 8/10:  85%|           | 17/20 [00:43<00:07,  2.44s/it, acc=1,
loss=0.0135]
 Epoch 8/10:  85%|           | 17/20 [00:45<00:07,  2.44s/it, acc=1,
loss=0.0133]
 Epoch 8/10:  90%|           | 18/20 [00:45<00:04,  2.36s/it, acc=1,
loss=0.0133]
```

```
 Epoch 8/10:  90%|        | 18/20 [00:47<00:04,  2.36s/it, acc=1,
loss=0.0132]
 Epoch 8/10:  95%|        | 19/20 [00:47<00:02,  2.34s/it, acc=1,
loss=0.0132]
 Epoch 8/10:  95%|        | 19/20 [00:48<00:02,  2.34s/it, acc=1,
loss=0.0135]
 Epoch 8/10: 100%|        | 20/20 [00:48<00:00,  1.99s/it, acc=1,
loss=0.0135]
 Epoch 8/10: 100%|        | 20/20 [00:48<00:00,  2.44s/it, acc=1,
loss=0.0135]


Epoch 8 - Loss: 0.0132 - Accuracy: 1.0000
 Epoch 9/10:   0%|                          | 0/20 [00:00<?,
?it/s]
 Epoch 9/10:   0%|               | 0/20 [00:01<?, ?it/s, acc=1,
loss=0.0127]
 Epoch 9/10:   5%|        | 1/20 [00:01<00:37,  1.97s/it, acc=1,
loss=0.0127]
 Epoch 9/10:   5%|        | 1/20 [00:08<00:37,  1.97s/it, acc=1,
loss=0.0114]
 Epoch 9/10:  10%|        | 2/20 [00:08<01:24,  4.70s/it, acc=1,
loss=0.0114]
 Epoch 9/10:  10%|        | 2/20 [00:10<01:24,  4.70s/it, acc=1,
loss=0.0114]
 Epoch 9/10:  15%|        | 3/20 [00:10<01:01,  3.64s/it, acc=1,
loss=0.0114]
 Epoch 9/10:  15%|        | 3/20 [00:12<01:01,  3.64s/it, acc=1,
loss=0.0113]
 Epoch 9/10:  20%|        | 4/20 [00:12<00:47,  2.97s/it, acc=1,
loss=0.0113]
 Epoch 9/10:  20%|        | 4/20 [00:15<00:47,  2.97s/it, acc=1,
loss=0.0112]
 Epoch 9/10:  25%|        | 5/20 [00:15<00:43,  2.91s/it, acc=1,
loss=0.0112]
 Epoch 9/10:  25%|        | 5/20 [00:18<00:43,  2.91s/it, acc=1,
loss=0.0111]
 Epoch 9/10:  30%|        | 6/20 [00:18<00:38,  2.74s/it, acc=1,
loss=0.0111]
```

```
Epoch 9/10:  30%|              | 6/20 [00:20<00:38,  2.74s/it, acc=1,
loss=0.011]

 Epoch 9/10:  35%|              | 7/20 [00:20<00:34,  2.62s/it, acc=1,
loss=0.011]

 Epoch 9/10:  35%|             | 7/20 [00:22<00:34,  2.62s/it, acc=1,
loss=0.0109]

 Epoch 9/10:  40%|             | 8/20 [00:22<00:29,  2.47s/it, acc=1,
loss=0.0109]

 Epoch 9/10:  40%|             | 8/20 [00:25<00:29,  2.47s/it, acc=1,
loss=0.0109]

 Epoch 9/10:  45%|            | 9/20 [00:25<00:26,  2.45s/it, acc=1,
loss=0.0109]

 Epoch 9/10:  45%|            | 9/20 [00:27<00:26,  2.45s/it, acc=1,
loss=0.0108]

 Epoch 9/10:  50%|           | 10/20 [00:27<00:24,  2.41s/it, acc=1,
loss=0.0108]

 Epoch 9/10:  50%|           | 10/20 [00:29<00:24,  2.41s/it, acc=1,
loss=0.0107]

 Epoch 9/10:  55%|           | 11/20 [00:29<00:21,  2.40s/it, acc=1,
loss=0.0107]

 Epoch 9/10:  55%|           | 11/20 [00:32<00:21,  2.40s/it, acc=1,
loss=0.0108]

 Epoch 9/10:  60%|          | 12/20 [00:32<00:18,  2.36s/it, acc=1,
loss=0.0108]

 Epoch 9/10:  60%|          | 12/20 [00:34<00:18,  2.36s/it, acc=1,
loss=0.0107]

 Epoch 9/10:  65%|          | 13/20 [00:34<00:16,  2.35s/it, acc=1,
loss=0.0107]

 Epoch 9/10:  65%|          | 13/20 [00:36<00:16,  2.35s/it, acc=1,
loss=0.0107]

 Epoch 9/10:  70%|         | 14/20 [00:36<00:13,  2.30s/it, acc=1,
loss=0.0107]

 Epoch 9/10:  70%|         | 14/20 [00:42<00:13,  2.30s/it, acc=1,
loss=0.0106]

 Epoch 9/10:  75%|        | 15/20 [00:42<00:17,  3.45s/it, acc=1,
loss=0.0106]

 Epoch 9/10:  75%|        | 15/20 [00:44<00:17,  3.45s/it, acc=1,
loss=0.0105]
```

```
 Epoch 9/10:   80%|          | 16/20 [00:44<00:12,  3.11s/it, acc=1,
loss=0.0105]
 Epoch 9/10:   80%|          | 16/20 [00:47<00:12,  3.11s/it, acc=1,
loss=0.0104]
 Epoch 9/10:   85%|          | 17/20 [00:47<00:08,  2.92s/it, acc=1,
loss=0.0104]
 Epoch 9/10:   85%|          | 17/20 [00:49<00:08,  2.92s/it, acc=1,
loss=0.0104]
 Epoch 9/10:   90%|          | 18/20 [00:49<00:05,  2.79s/it, acc=1,
loss=0.0104]
 Epoch 9/10:   90%|          | 18/20 [00:52<00:05,  2.79s/it, acc=1,
loss=0.0103]
 Epoch 9/10:   95%|          | 19/20 [00:52<00:02,  2.70s/it, acc=1,
loss=0.0103]
 Epoch 9/10:   95%|          | 19/20 [00:53<00:02,  2.70s/it, acc=1,
loss=0.0105]
 Epoch 9/10:  100%|          | 20/20 [00:53<00:00,  2.23s/it, acc=1,
loss=0.0105]
 Epoch 9/10:  100%|          | 20/20 [00:53<00:00,  2.68s/it, acc=1,
loss=0.0105]

Epoch 9 - Loss: 0.0103 - Accuracy: 1.0000
 Epoch 10/10:    0%|                            | 0/20 [00:00<?,
?it/s]
 Epoch 10/10:    0%|                  | 0/20 [00:01<?, ?it/s, acc=1,
loss=0.00893]
 Epoch 10/10:    5%|          | 1/20 [00:01<00:37,  1.98s/it, acc=1,
loss=0.00893]
 Epoch 10/10:    5%|          | 1/20 [00:04<00:37,  1.98s/it, acc=1,
loss=0.00909]
 Epoch 10/10:   10%|          | 2/20 [00:04<00:40,  2.26s/it, acc=1,
loss=0.00909]
 Epoch 10/10:   10%|          | 2/20 [00:06<00:40,  2.26s/it, acc=1,
loss=0.00911]
 Epoch 10/10:   15%|          | 3/20 [00:06<00:38,  2.28s/it, acc=1,
loss=0.00911]
 Epoch 10/10:   15%|          | 3/20 [00:09<00:38,  2.28s/it, acc=1,
loss=0.00901]
```

```
Epoch 10/10:  20%|             | 4/20 [00:09<00:38,  2.42s/it, acc=1,
loss=0.00901]
Epoch 10/10:  20%|             | 4/20 [00:11<00:38,  2.42s/it, acc=1,
loss=0.00907]
Epoch 10/10:  25%|             | 5/20 [00:11<00:34,  2.33s/it, acc=1,
loss=0.00907]
Epoch 10/10:  25%|             | 5/20 [00:14<00:34,  2.33s/it, acc=1,
loss=0.009]
Epoch 10/10:  30%|             | 6/20 [00:14<00:34,  2.46s/it, acc=1,
loss=0.009]
Epoch 10/10:  30%|             | 6/20 [00:16<00:34,  2.46s/it, acc=1,
loss=0.00883]
Epoch 10/10:  35%|             | 7/20 [00:16<00:31,  2.40s/it, acc=1,
loss=0.00883]
Epoch 10/10:  35%|             | 7/20 [00:19<00:31,  2.40s/it, acc=1,
loss=0.00881]
Epoch 10/10:  40%|             | 8/20 [00:19<00:30,  2.51s/it, acc=1,
loss=0.00881]
Epoch 10/10:  40%|             | 8/20 [00:25<00:30,  2.51s/it, acc=1,
loss=0.00879]
Epoch 10/10:  45%|             | 9/20 [00:25<00:40,  3.65s/it, acc=1,
loss=0.00879]
Epoch 10/10:  45%|             | 9/20 [00:27<00:40,  3.65s/it, acc=1,
loss=0.00869]
Epoch 10/10:  50%|             | 10/20 [00:27<00:32,  3.25s/it, acc=1,
loss=0.00869]
Epoch 10/10:  50%|             | 10/20 [00:30<00:32,  3.25s/it, acc=1,
loss=0.00866]
Epoch 10/10:  55%|             | 11/20 [00:30<00:26,  2.97s/it, acc=1,
loss=0.00866]
Epoch 10/10:  55%|             | 11/20 [00:32<00:26,  2.97s/it, acc=1,
loss=0.00862]
Epoch 10/10:  60%|             | 12/20 [00:32<00:21,  2.69s/it, acc=1,
loss=0.00862]
Epoch 10/10:  60%|             | 12/20 [00:34<00:21,  2.69s/it, acc=1,
loss=0.00856]
Epoch 10/10:  65%|             | 13/20 [00:34<00:18,  2.69s/it, acc=1,
loss=0.00856]
```

```
Epoch 10/10:  65%|        | 13/20 [00:36<00:18,  2.69s/it, acc=1,
loss=0.00844]

Epoch 10/10:  70%|        | 14/20 [00:36<00:14,  2.50s/it, acc=1,
loss=0.00844]

Epoch 10/10:  70%|        | 14/20 [00:39<00:14,  2.50s/it, acc=1,
loss=0.00837]

Epoch 10/10:  75%|        | 15/20 [00:39<00:12,  2.45s/it, acc=1,
loss=0.00837]

Epoch 10/10:  75%|        | 15/20 [00:41<00:12,  2.45s/it, acc=1,
loss=0.00831]

Epoch 10/10:  80%|        | 16/20 [00:41<00:09,  2.36s/it, acc=1,
loss=0.00831]

Epoch 10/10:  80%|        | 16/20 [00:43<00:09,  2.36s/it, acc=1,
loss=0.00827]

Epoch 10/10:  85%|        | 17/20 [00:43<00:07,  2.40s/it, acc=1,
loss=0.00827]

Epoch 10/10:  85%|        | 17/20 [00:46<00:07,  2.40s/it, acc=1,
loss=0.00821]

Epoch 10/10:  90%|        | 18/20 [00:46<00:04,  2.49s/it, acc=1,
loss=0.00821]

Epoch 10/10:  90%|        | 18/20 [00:49<00:04,  2.49s/it, acc=1,
loss=0.00817]

Epoch 10/10:  95%|        | 19/20 [00:49<00:02,  2.50s/it, acc=1,
loss=0.00817]

Epoch 10/10:  95%|        | 19/20 [00:49<00:02,  2.50s/it, acc=1,
loss=0.00838]

Epoch 10/10: 100%|        | 20/20 [00:49<00:00,  2.01s/it, acc=1,
loss=0.00838]

Epoch 10/10: 100%|        | 20/20 [00:49<00:00,  2.50s/it, acc=1,
loss=0.00838]


Epoch 10 - Loss: 0.0082 - Accuracy: 1.0000
Modèle sauvegardé dans : /home/zoidberg/Zoidberg/models/mobilenet_pneumonia.pt
```

```
[5]: model.eval()
y_true, y_pred = [], []
labels = [0, 1, 2]
with torch.no_grad():
    for inputs, labels_batch in tqdm(val_loader, desc="Évaluation", file=sys.
     ↪stdout):
```

```
        outputs = model(inputs.to(DEVICE))
        _, preds = torch.max(outputs, 1)
        y_true.extend(labels_batch.numpy())
        y_pred.extend(preds.cpu().numpy())

print("Répartition réelle dans y_true :", Counter(y_true))
print("Répartition prédite dans y_pred :", Counter(y_pred))

cm = confusion_matrix(y_true, y_pred, labels=labels)
report = classification_report(y_true, y_pred, labels=labels,␣
 ↪target_names=dataset.classes, zero_division=0)
print(report)
sns.heatmap(cm, annot=True, fmt='d', cmap='Blues', xticklabels=dataset.classes,␣
 ↪yticklabels=dataset.classes)
plt.title(f"Matrice de confusion ({TIMESTAMP})")
plt.xlabel("Prédit")
plt.ylabel("Réel")
plt.tight_layout()
plt.show()
```

Évaluation: 0%| | 0/20 [00:00<?,
?it/s]

Évaluation: 5%| | 1/20 [00:01<00:22,
1.17s/it]

Évaluation: 10%| | 2/20 [00:02<00:21,
1.19s/it]

Évaluation: 15%| | 3/20 [00:03<00:19,
1.16s/it]

Évaluation: 20%| | 4/20 [00:07<00:36,
2.28s/it]

Évaluation: 25%| | 5/20 [00:09<00:32,
2.20s/it]

Évaluation: 30%| | 6/20 [00:10<00:24,
1.74s/it]

Évaluation: 35%| | 7/20 [00:11<00:19,
1.47s/it]

Évaluation: 40%| | 8/20 [00:12<00:15,
1.33s/it]

Évaluation: 45%| | 9/20 [00:13<00:13,
1.18s/it]

Évaluation: 50%| | 10/20 [00:13<00:09,
1.01it/s]

```
Évaluation:  55%|                          | 11/20 [00:14<00:07,
1.16it/s]

Évaluation:  60%|                          | 12/20 [00:14<00:06,
1.29it/s]

Évaluation:  65%|                          | 13/20 [00:15<00:05,
1.27it/s]

Évaluation:  70%|                          | 14/20 [00:16<00:04,
1.21it/s]

Évaluation:  75%|                          | 15/20 [00:17<00:04,
1.23it/s]

Évaluation:  80%|                          | 16/20 [00:18<00:03,
1.19it/s]

Évaluation:  85%|                          | 17/20 [00:18<00:02,
1.28it/s]

Évaluation:  90%|                          | 18/20 [00:19<00:01,
1.38it/s]

Évaluation:  95%|                          | 19/20 [00:20<00:00,
1.45it/s]

Évaluation: 100%|                          | 20/20 [00:20<00:00,
1.77it/s]

Évaluation: 100%|                          | 20/20 [00:20<00:00,
1.02s/it]


Répartition réelle dans y_true : Counter({np.int64(0): 624})
Répartition prédite dans y_pred : Counter({np.int64(0): 624})
              precision    recall  f1-score    support

      NORMAL       1.00      1.00      1.00        624
   bacterial       0.00      0.00      0.00          0
       viral       0.00      0.00      0.00          0

    accuracy                           1.00        624
   macro avg       0.33      0.33      0.33        624
weighted avg       1.00      1.00      1.00        624
```

Matrice de confusion (20250506_093849)