⌄ Train a Neural Network to Predict Quality of Wine

Artificial Neural Networks at the Service of Wine Authenticity
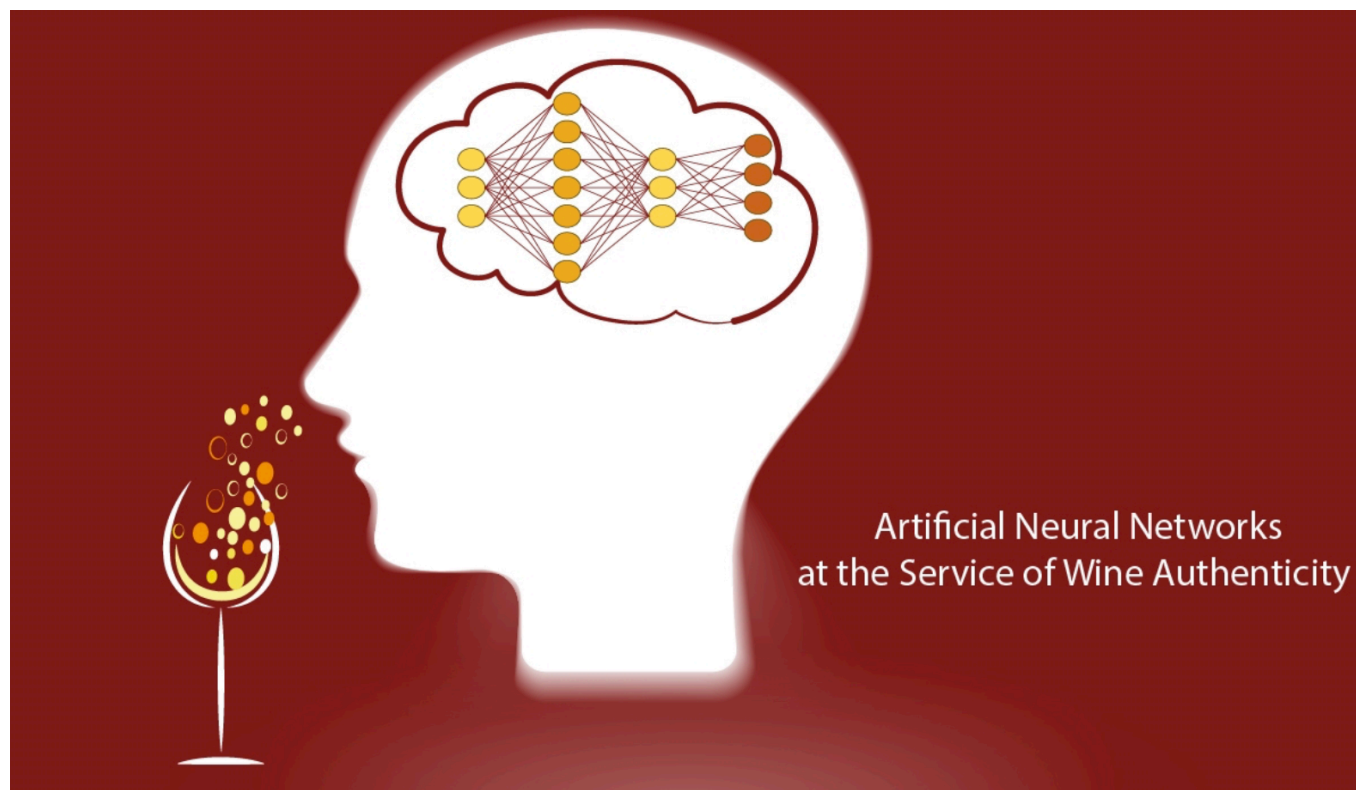
- In this lab, you will first train a neural network on a public dataset, then make several enhancements to the lab.
- Tasks breakdown:

  - Code running: 10%
  - Enhancement 1: 15%
  - Enhancement 2: 15%
  - Enhancement 3: 10%
  - Enhancement 4: 10%
  - Enhancement 5: 40%

⌄ Imports

```
import pandas as pd
import torch
import torch.nn as nn
import torch.nn.functional as F
from torch.optim import AdamW
from torch.utils.data import Dataset, DataLoader
from tqdm.notebook import tqdm
```

⌄ Dataset

```
data_df = pd.read_csv('winequality-red.csv')
```

```
data_df.head()
```

```
print(data_df.info())
```

```
    <class 'pandas.core.frame.DataFrame'>
    RangeIndex: 1599 entries, 0 to 1598
    Data columns (total 12 columns):
     #   Column                Non-Null Count  Dtype
```

```
 ---   ------                  --------------   -----
  0    fixed acidity           1599 non-null    float64
  1    volatile acidity        1599 non-null    float64
  2    citric acid             1599 non-null    float64
  3    residual sugar          1599 non-null    float64
  4    chlorides               1599 non-null    float64
  5    free sulfur dioxide     1599 non-null    float64
  6    total sulfur dioxide    1599 non-null    float64
  7    density                 1599 non-null    float64
  8    pH                      1599 non-null    float64
  9    sulphates               1599 non-null    float64
  10   alcohol                 1599 non-null    float64
  11   quality                 1599 non-null    int64
dtypes: float64(11), int64(1)
memory usage: 150.0 KB
None
```

```python
# how many features?
len(data_df.columns) - 1
```

⤵ 11

```python
# how many labels? If yours is a binary classification task, then you'll have 2 labels.
data_df.quality.unique()
```

⤵ array([5, 6, 7, 4, 8, 3])

```python
# convert these quaity measures to labels (0 to 5)
def get_label(quality):
    if quality == 3:
        return 0
    elif quality == 4:
        return 1
    elif quality == 5:
        return 2
    elif quality == 6:
        return 3
    elif quality == 7:
        return 4
    else:
        return 5

labels = data_df['quality'].apply(get_label)

# normalize data
data_df = (data_df - data_df.mean()) / data_df.std()
data_df['label'] = labels


data_df.head()
```

⤵

	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density	pH	sulphates	alcohol	quality	label
0	-0.528194	0.961576	-1.391037	-0.453077	-0.243630	-0.466047	-0.379014	0.558100	1.288240	-0.579025	-0.959946	-0.787576	2
1	-0.298454	1.966827	-1.391037	0.043403	0.223805	0.872365	0.624168	0.028252	-0.719708	0.128910	-0.584594	-0.787576	2
2	-0.298454	1.296660	-1.185699	-0.169374	0.096323	-0.083643	0.228975	0.134222	-0.331073	-0.048074	-0.584594	-0.787576	2
3	1.654339	-1.384011	1.483689	-0.453077	-0.264878	0.107558	0.411372	0.664069	-0.978798	-0.461036	-0.584594	0.450707	3

Next steps: Generate code with `data_df`   ◐ View recommended plots   New interactive sheet
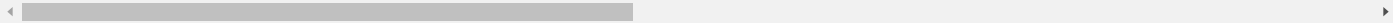
```python
# sumamry statistics of the data
data_df.describe()
```

	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density	pH
count	1.599000e+03	1.599000e+03	1.599000e+03	1.599000e+03	1.599000e+03	1.599000e+03	1.599000e+03	1.599000e+03	1.599000e+03
mean	3.554936e-16	1.688594e-16	-1.066481e-16	-1.110917e-16	2.132961e-16	-6.221137e-17	2.666202e-17	-3.469617e-14	2.861723e-15
std	1.000000e+00	1.000000e+00	1.000000e+00	1.000000e+00	1.000000e+00	1.000000e+00	1.000000e+00	1.000000e+00	1.000000e+00
min	-2.136377e+00	-2.277567e+00	-1.391037e+00	-1.162333e+00	-1.603443e+00	-1.422055e+00	-1.230199e+00	-3.537625e+00	-3.699244e+00
25%	-7.004996e-01	-7.696903e-01	-9.290275e-01	-4.530767e-01	-3.711129e-01	-8.484502e-01	-7.438076e-01	-6.075656e-01	-6.549356e-01
50%	-2.410190e-01	-4.367545e-02	-5.634264e-02	-2.402999e-01	-1.798892e-01	-1.792441e-01	-2.574163e-01	1.759533e-03	-7.210449e-03
75%	5.056370e-01	6.264921e-01	7.650078e-01	4.340257e-02	5.382858e-02	4.899619e-01	4.721707e-01	5.766445e-01	5.757422e-01

Load this dataset for training a neural network

```python
# The dataset class
class WineDataset(Dataset):

    def __init__(self, data_df):
        self.data_df = data_df
        self.features = []
        self.labels = []
        for _, i in data_df.iterrows():
            self.features.append([i['fixed acidity'], i['volatile acidity'], i['citric acid'], i['residual sugar'], i['chlorides'], i['free su
            self.labels.append(i['label'])

    def __len__(self):
        return len(self.data_df)

    def __getitem__(self, idx):
        if torch.is_tensor(idx):
            idx = idx.tolist()

        features = self.features[idx]
        features = torch.FloatTensor(features)

        labels = torch.tensor(self.labels[idx], dtype = torch.long)

        return {'labels': labels, 'features': features}

wine_dataset = WineDataset(data_df)
train_dataset, val_dataset, test_dataset = torch.utils.data.random_split(wine_dataset, [0.8, 0.1, 0.1])

# The dataloader
train_dataloader = DataLoader(train_dataset, batch_size = 4, shuffle = True, num_workers = 0)
val_dataloader = DataLoader(val_dataset, batch_size = 4, shuffle = False, num_workers = 0)
test_dataloader = DataLoader(test_dataset, batch_size = 4, shuffle = False, num_workers = 0)

# peak into the dataset
for i in wine_dataset:
    print(i)
    break
```

```
{'labels': tensor(2), 'features': tensor([-0.5282,  0.9616, -1.3910, -0.4531, -0.2436, -0.4660, -0.3790,  0.5581,
         1.2882, -0.5790, -0.9599])}
```

Neural Network

```python
# change the device to gpu if available
device = torch.device('cuda' if torch.cuda.is_available() else 'cpu')


class WineModel(torch.nn.Module):

    def __init__(self):
        super(WineModel, self).__init__()

        self.linear1 = torch.nn.Linear(11, 200)
```

```python
        self.activation = torch.nn.ReLU()
        self.linear2 = torch.nn.Linear(200, 6)
        self.softmax = torch.nn.Softmax()

    def forward(self, x):
        x = self.linear1(x)
        x = self.activation(x)
        x = self.linear2(x)
        x = self.softmax(x)
        return x

winemodel = WineModel().to(device)
```

⌄ Training

```python
# Define and the loss function and optimizer
criterion = nn.CrossEntropyLoss().to(device)
optimizer = AdamW(winemodel.parameters(), lr = 1e-3)
```

```python
# Lets define the training steps
def accuracy(preds, labels):
    preds = torch.argmax(preds, dim=1).flatten()
    labels = labels.flatten()
    return torch.sum(preds == labels) / len(labels)

def train(model, data_loader, optimizer, criterion):
  epoch_loss = 0
  epoch_acc = 0

  model.train()
  for d in tqdm(data_loader):
    inputs = d['features'].to(device)
    labels = d['labels'].to(device)
    outputs = winemodel(inputs)

    _, preds = torch.max(outputs, dim=1)
    loss = criterion(outputs, labels)
    acc = accuracy(outputs, labels)

    loss.backward()
    optimizer.step()
    optimizer.zero_grad()

    epoch_loss += loss.item()
    epoch_acc += acc.item()

  return epoch_loss / len(data_loader), epoch_acc / len(data_loader)

# Lets define the testing steps
def evaluate(model, data_loader, criterion):
    epoch_loss = 0
    epoch_acc = 0

    model.eval()
    with torch.no_grad():
      for d in data_loader:
        inputs = d['features'].to(device)
        labels = d['labels'].to(device)
        outputs = winemodel(inputs)

        _, preds = torch.max(outputs, dim=1)
        loss = criterion(outputs, labels)
        acc = accuracy(outputs, labels)

        epoch_loss += loss.item()
        epoch_acc += acc.item()

    return epoch_loss / len(data_loader), epoch_acc / len(data_loader)

# Let's train our model
for epoch in range(100):
    train_loss, train_acc = train(winemodel, train_dataloader, optimizer, criterion)
    valid_loss, valid_acc = evaluate(winemodel, val_dataloader, criterion)
```

```python
print(f'| Epoch: {epoch+1:02} | Train Loss: {train_loss:.3f} | Train Acc: {train_acc*100:.2f}% | Val. Loss: {valid_loss:.3f} | Val. Acc:
```

⇅ 100%   320/320 [00:00<00:00, 588.79it/s]
/usr/local/lib/python3.10/dist-packages/torch/nn/modules/module.py:1553: UserWarning: Implicit dimension choice for softmax has been dep
  return self._call_impl(*args, **kwargs)
| Epoch: 01 | Train Loss: 1.516 | Train Acc: 56.17% | Val. Loss: 1.536 | Val. Acc: 51.25% |
100%   320/320 [00:00<00:00, 593.87it/s]
| Epoch: 02 | Train Loss: 1.447 | Train Acc: 60.23% | Val. Loss: 1.538 | Val. Acc: 48.12% |
100%   320/320 [00:00<00:00, 398.14it/s]
| Epoch: 03 | Train Loss: 1.437 | Train Acc: 60.62% | Val. Loss: 1.525 | Val. Acc: 51.88% |
100%   320/320 [00:00<00:00, 504.30it/s]
| Epoch: 04 | Train Loss: 1.431 | Train Acc: 60.94% | Val. Loss: 1.526 | Val. Acc: 50.62% |
100%   320/320 [00:00<00:00, 380.61it/s]
| Epoch: 05 | Train Loss: 1.427 | Train Acc: 62.19% | Val. Loss: 1.529 | Val. Acc: 52.50% |
100%   320/320 [00:00<00:00, 403.74it/s]
| Epoch: 06 | Train Loss: 1.425 | Train Acc: 61.09% | Val. Loss: 1.521 | Val. Acc: 53.12% |
100%   320/320 [00:00<00:00, 468.33it/s]
| Epoch: 07 | Train Loss: 1.418 | Train Acc: 62.11% | Val. Loss: 1.522 | Val. Acc: 51.88% |
100%   320/320 [00:00<00:00, 464.34it/s]
| Epoch: 08 | Train Loss: 1.418 | Train Acc: 62.58% | Val. Loss: 1.521 | Val. Acc: 50.62% |
100%   320/320 [00:00<00:00, 534.51it/s]
| Epoch: 09 | Train Loss: 1.416 | Train Acc: 62.42% | Val. Loss: 1.517 | Val. Acc: 53.12% |
100%   320/320 [00:00<00:00, 567.52it/s]
| Epoch: 10 | Train Loss: 1.411 | Train Acc: 63.36% | Val. Loss: 1.509 | Val. Acc: 54.37% |
100%   320/320 [00:00<00:00, 613.89it/s]
| Epoch: 11 | Train Loss: 1.409 | Train Acc: 63.59% | Val. Loss: 1.520 | Val. Acc: 51.88% |
100%   320/320 [00:00<00:00, 545.76it/s]
| Epoch: 12 | Train Loss: 1.406 | Train Acc: 64.38% | Val. Loss: 1.517 | Val. Acc: 53.75% |
100%   320/320 [00:00<00:00, 668.20it/s]
| Epoch: 13 | Train Loss: 1.406 | Train Acc: 64.22% | Val. Loss: 1.520 | Val. Acc: 52.50% |
100%   320/320 [00:00<00:00, 503.20it/s]
| Epoch: 14 | Train Loss: 1.403 | Train Acc: 64.38% | Val. Loss: 1.519 | Val. Acc: 52.50% |
100%   320/320 [00:00<00:00, 579.28it/s]
| Epoch: 15 | Train Loss: 1.403 | Train Acc: 64.69% | Val. Loss: 1.520 | Val. Acc: 51.88% |
100%   320/320 [00:00<00:00, 617.63it/s]
| Epoch: 16 | Train Loss: 1.400 | Train Acc: 64.84% | Val. Loss: 1.524 | Val. Acc: 50.00% |
100%   320/320 [00:00<00:00, 551.23it/s]
| Epoch: 17 | Train Loss: 1.397 | Train Acc: 65.08% | Val. Loss: 1.517 | Val. Acc: 52.50% |
100%   320/320 [00:00<00:00, 589.14it/s]
| Epoch: 18 | Train Loss: 1.396 | Train Acc: 65.08% | Val. Loss: 1.519 | Val. Acc: 52.50% |
100%   320/320 [00:00<00:00, 556.07it/s]
| Epoch: 19 | Train Loss: 1.394 | Train Acc: 65.16% | Val. Loss: 1.524 | Val. Acc: 51.25% |
100%   320/320 [00:00<00:00, 544.06it/s]
| Epoch: 20 | Train Loss: 1.394 | Train Acc: 65.39% | Val. Loss: 1.521 | Val. Acc: 51.88% |
100%   320/320 [00:00<00:00, 625.76it/s]
| Epoch: 21 | Train Loss: 1.393 | Train Acc: 64.92% | Val. Loss: 1.520 | Val. Acc: 51.25% |
100%   320/320 [00:00<00:00, 532.11it/s]
| Epoch: 22 | Train Loss: 1.390 | Train Acc: 65.94% | Val. Loss: 1.518 | Val. Acc: 50.62% |
100%   320/320 [00:00<00:00, 671.36it/s]
| Epoch: 23 | Train Loss: 1.390 | Train Acc: 65.62% | Val. Loss: 1.527 | Val. Acc: 50.62% |
100%   320/320 [00:00<00:00, 561.13it/s]
| Epoch: 24 | Train Loss: 1.387 | Train Acc: 65.94% | Val. Loss: 1.521 | Val. Acc: 51.88% |
100%   320/320 [00:00<00:00, 441.68it/s]
| Epoch: 25 | Train Loss: 1.385 | Train Acc: 65.86% | Val. Loss: 1.522 | Val. Acc: 51.25% |
100%   320/320 [00:00<00:00, 452.77it/s]
| Epoch: 26 | Train Loss: 1.385 | Train Acc: 66.17% | Val. Loss: 1.525 | Val. Acc: 51.25% |
100%   320/320 [00:00<00:00, 445.07it/s]
| Epoch: 27 | Train Loss: 1.386 | Train Acc: 66.25% | Val. Loss: 1.519 | Val. Acc: 53.12% |
100%   320/320 [00:00<00:00, 412.51it/s]
| Epoch: 28 | Train Loss: 1.382 | Train Acc: 66.56% | Val. Loss: 1.525 | Val. Acc: 50.62% |
100%   320/320 [00:00<00:00, 448.00it/s]
| Epoch: 29 | Train Loss: 1.382 | Train Acc: 66.64% | Val. Loss: 1.521 | Val. Acc: 52.50% |

```
100%                                           320/320 [00:00<00:00, 490.10it/s]
| Epoch: 30 | Train Loss: 1.381 | Train Acc: 66.72% | Val. Loss: 1.519 | Val. Acc: 52.50% |
100%                                           320/320 [00:00<00:00, 641.49it/s]
| Epoch: 31 | Train Loss: 1.378 | Train Acc: 67.50% | Val. Loss: 1.514 | Val. Acc: 51.25% |
100%                                           320/320 [00:00<00:00, 566.05it/s]
| Epoch: 32 | Train Loss: 1.378 | Train Acc: 67.58% | Val. Loss: 1.518 | Val. Acc: 52.50% |
100%                                           320/320 [00:00<00:00, 561.34it/s]
| Epoch: 33 | Train Loss: 1.375 | Train Acc: 67.50% | Val. Loss: 1.518 | Val. Acc: 51.88% |
100%                                           320/320 [00:00<00:00, 644.38it/s]
| Epoch: 34 | Train Loss: 1.377 | Train Acc: 66.95% | Val. Loss: 1.516 | Val. Acc: 51.88% |
100%                                           320/320 [00:00<00:00, 538.98it/s]
| Epoch: 35 | Train Loss: 1.374 | Train Acc: 67.81% | Val. Loss: 1.522 | Val. Acc: 52.50% |
100%                                           320/320 [00:00<00:00, 619.80it/s]
| Epoch: 36 | Train Loss: 1.373 | Train Acc: 67.89% | Val. Loss: 1.518 | Val. Acc: 52.50% |
100%                                           320/320 [00:00<00:00, 576.67it/s]
| Epoch: 37 | Train Loss: 1.371 | Train Acc: 67.97% | Val. Loss: 1.519 | Val. Acc: 52.50% |
100%                                           320/320 [00:00<00:00, 545.26it/s]
| Epoch: 38 | Train Loss: 1.372 | Train Acc: 67.89% | Val. Loss: 1.516 | Val. Acc: 52.50% |
100%                                           320/320 [00:00<00:00, 636.35it/s]
| Epoch: 39 | Train Loss: 1.370 | Train Acc: 68.12% | Val. Loss: 1.514 | Val. Acc: 53.75% |
100%                                           320/320 [00:00<00:00, 507.82it/s]
| Epoch: 40 | Train Loss: 1.369 | Train Acc: 68.05% | Val. Loss: 1.512 | Val. Acc: 53.12% |
100%                                           320/320 [00:00<00:00, 576.48it/s]
| Epoch: 41 | Train Loss: 1.369 | Train Acc: 68.52% | Val. Loss: 1.513 | Val. Acc: 53.12% |
100%                                           320/320 [00:00<00:00, 612.61it/s]
| Epoch: 42 | Train Loss: 1.366 | Train Acc: 68.59% | Val. Loss: 1.513 | Val. Acc: 52.50% |
100%                                           320/320 [00:00<00:00, 538.70it/s]
| Epoch: 43 | Train Loss: 1.366 | Train Acc: 68.83% | Val. Loss: 1.510 | Val. Acc: 54.37% |
100%                                           320/320 [00:00<00:00, 647.47it/s]
| Epoch: 44 | Train Loss: 1.366 | Train Acc: 68.91% | Val. Loss: 1.511 | Val. Acc: 53.75% |
100%                                           320/320 [00:00<00:00, 573.65it/s]
| Epoch: 45 | Train Loss: 1.362 | Train Acc: 69.38% | Val. Loss: 1.510 | Val. Acc: 55.00% |
100%                                           320/320 [00:00<00:00, 521.62it/s]
| Epoch: 46 | Train Loss: 1.363 | Train Acc: 69.38% | Val. Loss: 1.514 | Val. Acc: 53.12% |
100%                                           320/320 [00:00<00:00, 501.30it/s]
| Epoch: 47 | Train Loss: 1.360 | Train Acc: 69.22% | Val. Loss: 1.510 | Val. Acc: 53.75% |
100%                                           320/320 [00:00<00:00, 483.82it/s]
| Epoch: 48 | Train Loss: 1.360 | Train Acc: 69.53% | Val. Loss: 1.510 | Val. Acc: 55.00% |
100%                                           320/320 [00:00<00:00, 428.94it/s]
| Epoch: 49 | Train Loss: 1.358 | Train Acc: 69.53% | Val. Loss: 1.508 | Val. Acc: 52.50% |
100%                                           320/320 [00:00<00:00, 356.13it/s]
| Epoch: 50 | Train Loss: 1.358 | Train Acc: 70.00% | Val. Loss: 1.512 | Val. Acc: 53.75% |
100%                                           320/320 [00:01<00:00, 211.33it/s]
| Epoch: 51 | Train Loss: 1.358 | Train Acc: 69.53% | Val. Loss: 1.512 | Val. Acc: 53.75% |
100%                                           320/320 [00:00<00:00, 542.58it/s]
| Epoch: 52 | Train Loss: 1.359 | Train Acc: 69.61% | Val. Loss: 1.509 | Val. Acc: 53.75% |
100%                                           320/320 [00:00<00:00, 537.19it/s]
| Epoch: 53 | Train Loss: 1.356 | Train Acc: 69.77% | Val. Loss: 1.514 | Val. Acc: 53.12% |
100%                                           320/320 [00:00<00:00, 397.13it/s]
| Epoch: 54 | Train Loss: 1.353 | Train Acc: 70.47% | Val. Loss: 1.511 | Val. Acc: 53.12% |
100%                                           320/320 [00:00<00:00, 537.67it/s]
| Epoch: 55 | Train Loss: 1.354 | Train Acc: 69.92% | Val. Loss: 1.510 | Val. Acc: 53.12% |
100%                                           320/320 [00:00<00:00, 631.94it/s]
| Epoch: 56 | Train Loss: 1.353 | Train Acc: 70.23% | Val. Loss: 1.515 | Val. Acc: 53.12% |
100%                                           320/320 [00:00<00:00, 502.14it/s]
| Epoch: 57 | Train Loss: 1.354 | Train Acc: 70.16% | Val. Loss: 1.514 | Val. Acc: 51.88% |
100%                                           320/320 [00:00<00:00, 552.90it/s]
| Epoch: 58 | Train Loss: 1.352 | Train Acc: 69.77% | Val. Loss: 1.511 | Val. Acc: 54.37% |
100%                                           320/320 [00:00<00:00, 559.92it/s]
```

```
| Epoch: 59 | Train Loss: 1.352 | Train Acc: 70.16% | Val. Loss: 1.509 | Val. Acc: 53.12% |
100%                                    320/320 [00:00<00:00, 567.32it/s]
| Epoch: 60 | Train Loss: 1.349 | Train Acc: 70.47% | Val. Loss: 1.510 | Val. Acc: 54.37% |
100%                                    320/320 [00:00<00:00, 622.41it/s]
| Epoch: 61 | Train Loss: 1.350 | Train Acc: 70.08% | Val. Loss: 1.512 | Val. Acc: 53.12% |
100%                                    320/320 [00:00<00:00, 560.02it/s]
| Epoch: 62 | Train Loss: 1.349 | Train Acc: 70.31% | Val. Loss: 1.505 | Val. Acc: 54.37% |
100%                                    320/320 [00:00<00:00, 537.98it/s]
| Epoch: 63 | Train Loss: 1.348 | Train Acc: 70.86% | Val. Loss: 1.513 | Val. Acc: 51.25% |
100%                                    320/320 [00:00<00:00, 627.44it/s]
| Epoch: 64 | Train Loss: 1.347 | Train Acc: 70.86% | Val. Loss: 1.507 | Val. Acc: 54.37% |
100%                                    320/320 [00:00<00:00, 526.88it/s]
| Epoch: 65 | Train Loss: 1.346 | Train Acc: 70.78% | Val. Loss: 1.508 | Val. Acc: 53.75% |
100%                                    320/320 [00:00<00:00, 463.23it/s]
| Epoch: 66 | Train Loss: 1.346 | Train Acc: 70.86% | Val. Loss: 1.517 | Val. Acc: 52.50% |
100%                                    320/320 [00:00<00:00, 454.82it/s]
| Epoch: 67 | Train Loss: 1.346 | Train Acc: 70.62% | Val. Loss: 1.509 | Val. Acc: 53.12% |
100%                                    320/320 [00:00<00:00, 506.19it/s]
| Epoch: 68 | Train Loss: 1.344 | Train Acc: 70.78% | Val. Loss: 1.509 | Val. Acc: 55.00% |
100%                                    320/320 [00:00<00:00, 467.10it/s]
| Epoch: 69 | Train Loss: 1.345 | Train Acc: 71.02% | Val. Loss: 1.512 | Val. Acc: 52.50% |
100%                                    320/320 [00:00<00:00, 374.86it/s]
| Epoch: 70 | Train Loss: 1.343 | Train Acc: 71.33% | Val. Loss: 1.504 | Val. Acc: 54.37% |
100%                                    320/320 [00:00<00:00, 406.38it/s]
| Epoch: 71 | Train Loss: 1.347 | Train Acc: 70.31% | Val. Loss: 1.512 | Val. Acc: 53.12% |
100%                                    320/320 [00:00<00:00, 531.90it/s]
| Epoch: 72 | Train Loss: 1.344 | Train Acc: 71.17% | Val. Loss: 1.509 | Val. Acc: 53.12% |
100%                                    320/320 [00:00<00:00, 530.41it/s]
| Epoch: 73 | Train Loss: 1.341 | Train Acc: 71.64% | Val. Loss: 1.504 | Val. Acc: 55.62% |
100%                                    320/320 [00:00<00:00, 540.72it/s]
| Epoch: 74 | Train Loss: 1.342 | Train Acc: 71.02% | Val. Loss: 1.505 | Val. Acc: 54.37% |
100%                                    320/320 [00:00<00:00, 602.72it/s]
| Epoch: 75 | Train Loss: 1.342 | Train Acc: 71.41% | Val. Loss: 1.509 | Val. Acc: 53.75% |
100%                                    320/320 [00:00<00:00, 517.88it/s]
| Epoch: 76 | Train Loss: 1.340 | Train Acc: 71.09% | Val. Loss: 1.514 | Val. Acc: 52.50% |
100%                                    320/320 [00:00<00:00, 542.23it/s]
| Epoch: 77 | Train Loss: 1.341 | Train Acc: 71.09% | Val. Loss: 1.508 | Val. Acc: 53.12% |
100%                                    320/320 [00:00<00:00, 623.31it/s]
| Epoch: 78 | Train Loss: 1.340 | Train Acc: 71.41% | Val. Loss: 1.508 | Val. Acc: 53.12% |
100%                                    320/320 [00:00<00:00, 473.30it/s]
| Epoch: 79 | Train Loss: 1.339 | Train Acc: 71.33% | Val. Loss: 1.514 | Val. Acc: 49.38% |
100%                                    320/320 [00:00<00:00, 565.17it/s]
| Epoch: 80 | Train Loss: 1.337 | Train Acc: 71.72% | Val. Loss: 1.513 | Val. Acc: 51.88% |
100%                                    320/320 [00:00<00:00, 581.34it/s]
| Epoch: 81 | Train Loss: 1.336 | Train Acc: 71.88% | Val. Loss: 1.517 | Val. Acc: 50.62% |
100%                                    320/320 [00:00<00:00, 521.56it/s]
| Epoch: 82 | Train Loss: 1.335 | Train Acc: 71.56% | Val. Loss: 1.507 | Val. Acc: 53.75% |
100%                                    320/320 [00:00<00:00, 604.18it/s]
| Epoch: 83 | Train Loss: 1.333 | Train Acc: 71.88% | Val. Loss: 1.508 | Val. Acc: 53.75% |
100%                                    320/320 [00:00<00:00, 560.37it/s]
| Epoch: 84 | Train Loss: 1.334 | Train Acc: 71.80% | Val. Loss: 1.516 | Val. Acc: 51.88% |
100%                                    320/320 [00:00<00:00, 501.07it/s]
| Epoch: 85 | Train Loss: 1.333 | Train Acc: 72.11% | Val. Loss: 1.506 | Val. Acc: 53.75% |
100%                                    320/320 [00:00<00:00, 621.45it/s]
| Epoch: 86 | Train Loss: 1.331 | Train Acc: 72.27% | Val. Loss: 1.514 | Val. Acc: 51.88% |
100%                                    320/320 [00:00<00:00, 530.54it/s]
| Epoch: 87 | Train Loss: 1.330 | Train Acc: 72.34% | Val. Loss: 1.504 | Val. Acc: 53.75% |
100%                                    320/320 [00:00<00:00, 426.72it/s]
| Epoch: 88 | Train Loss: 1.329 | Train Acc: 72.73% | Val. Loss: 1.505 | Val. Acc: 54.37% |
100%                                    320/320 [00:00<00:00, 409.57it/s]
```

```
| Epoch: 89 | Train Loss: 1.331 | Train Acc: 72.27% | Val. Loss: 1.511 | Val. Acc: 52.50% |
100%                                          320/320 [00:00<00:00, 465.79it/s]
| Epoch: 90 | Train Loss: 1.327 | Train Acc: 72.81% | Val. Loss: 1.497 | Val. Acc: 53.12% |
100%                                          320/320 [00:00<00:00, 366.61it/s]
| Epoch: 91 | Train Loss: 1.324 | Train Acc: 73.12% | Val. Loss: 1.498 | Val. Acc: 53.75% |
100%                                          320/320 [00:00<00:00, 460.90it/s]
| Epoch: 92 | Train Loss: 1.319 | Train Acc: 73.67% | Val. Loss: 1.501 | Val. Acc: 53.12% |
100%                                          320/320 [00:00<00:00, 433.47it/s]
| Epoch: 93 | Train Loss: 1.317 | Train Acc: 73.59% | Val. Loss: 1.490 | Val. Acc: 55.62% |
100%                                          320/320 [00:00<00:00, 406.32it/s]
| Epoch: 94 | Train Loss: 1.313 | Train Acc: 74.38% | Val. Loss: 1.503 | Val. Acc: 52.50% |
100%                                          320/320 [00:00<00:00, 561.42it/s]
| Epoch: 95 | Train Loss: 1.314 | Train Acc: 74.14% | Val. Loss: 1.504 | Val. Acc: 52.50% |
100%                                          320/320 [00:00<00:00, 570.57it/s]
| Epoch: 96 | Train Loss: 1.312 | Train Acc: 74.30% | Val. Loss: 1.498 | Val. Acc: 52.50% |
100%                                          320/320 [00:00<00:00, 560.03it/s]
| Epoch: 97 | Train Loss: 1.309 | Train Acc: 74.61% | Val. Loss: 1.489 | Val. Acc: 54.37% |
100%                                          320/320 [00:00<00:00, 564.42it/s]
| Epoch: 98 | Train Loss: 1.310 | Train Acc: 74.69% | Val. Loss: 1.496 | Val. Acc: 53.75% |
100%                                          320/320 [00:00<00:00, 581.71it/s]
| Epoch: 99 | Train Loss: 1.308 | Train Acc: 74.61% | Val. Loss: 1.490 | Val. Acc: 55.00% |
100%                                          320/320 [00:00<00:00, 538.96it/s]
| Epoch: 100 | Train Loss: 1.308 | Train Acc: 74.77% | Val. Loss: 1.494 | Val. Acc: 53.75% |
```

⌄ Lab Enhancements

- These tasks are additional enhancements with less guidance.
- Report results means give us the accuracy, precision, recall and F1-score.

⌄ Enhancement 1: The current code does not actually evaluate the model on the test set, but it only evaluates it on the val set. When you write papers, you would ideally split the dataset into train, val and test. Train and val are both used in training, and the model trained on the training data, and evaluated on the val data. So why do we need test split? We report our results on the test split in papers. Also, we do cross-validation on the train/val split (covered in later labs).

Report the results of the model on the test split. (Hint: It would be exactly like the evaluation on the val dataset, except it would be done on the test dataset.)

⌄ Summary

- **Accuracy**: 64.17% suggests the model is making correct predictions a little over half the time.
- **Precision**: 0.61 indicates that when the model predicts a positive class, it is correct 61% of the time.
- **Recall**: 0.64 indicates that the model captures 64% of the true positive instances, meaning it is somewhat effective but still misses some positive cases.
- **F1-Score**: 0.62 reflects a reasonable balance between precision and recall.

```
# Define a function to evaluate the model on the test set
def test_evaluate(model, data_loader, criterion):
    epoch_loss = 0
    epoch_acc = 0

    model.eval()
    with torch.no_grad():
        for d in data_loader:
            inputs = d['features'].to(device)
            labels = d['labels'].to(device)
            outputs = winemodel(inputs)

            _, preds = torch.max(outputs, dim=1)
            loss = criterion(outputs, labels)
            acc = accuracy(outputs, labels)

            epoch_loss += loss.item()
            epoch_acc += acc.item()

    return epoch_loss / len(data_loader), epoch_acc / len(data_loader)

# After the training loop, add the test evaluation
for epoch in range(100):
    train_loss, train_acc = train(winemodel, train_dataloader, optimizer, criterion)
    valid_loss, valid_acc = evaluate(winemodel, val_dataloader, criterion)

    print(f'| Epoch: {epoch+1:02} | Train Loss: {train_loss:.3f} | Train Acc: {train_acc*100:.2f}% | Val. Loss: {valid_loss:.3f} | Val. Acc:

# Evaluate on the test set
test_loss, test_acc = test_evaluate(winemodel, test_dataloader, criterion)

print(f'| Test Loss: {test_loss:.3f} | Test Acc: {test_acc*100:.2f}% |')
```

100%   320/320 [00:00<00:00, 623.94it/s]
| Epoch: 01 | Train Loss: 1.310 | Train Acc: 74.69% | Val. Loss: 1.496 | Val. Acc: 54.37% |
100%   320/320 [00:00<00:00, 632.23it/s]
| Epoch: 02 | Train Loss: 1.310 | Train Acc: 74.30% | Val. Loss: 1.500 | Val. Acc: 53.12% |
100%   320/320 [00:00<00:00, 598.47it/s]
| Epoch: 03 | Train Loss: 1.303 | Train Acc: 75.16% | Val. Loss: 1.502 | Val. Acc: 52.50% |
100%   320/320 [00:00<00:00, 543.70it/s]
| Epoch: 04 | Train Loss: 1.304 | Train Acc: 75.16% | Val. Loss: 1.495 | Val. Acc: 54.37% |
100%   320/320 [00:00<00:00, 660.05it/s]
| Epoch: 05 | Train Loss: 1.301 | Train Acc: 75.39% | Val. Loss: 1.497 | Val. Acc: 53.12% |
100%   320/320 [00:00<00:00, 512.46it/s]
| Epoch: 06 | Train Loss: 1.302 | Train Acc: 75.39% | Val. Loss: 1.494 | Val. Acc: 54.37% |
100%   320/320 [00:00<00:00, 612.42it/s]
| Epoch: 07 | Train Loss: 1.301 | Train Acc: 75.55% | Val. Loss: 1.499 | Val. Acc: 53.75% |
100%   320/320 [00:00<00:00, 566.54it/s]
| Epoch: 08 | Train Loss: 1.298 | Train Acc: 75.78% | Val. Loss: 1.496 | Val. Acc: 53.12% |
100%   320/320 [00:00<00:00, 533.72it/s]
| Epoch: 09 | Train Loss: 1.297 | Train Acc: 76.02% | Val. Loss: 1.496 | Val. Acc: 53.12% |
100%   320/320 [00:00<00:00, 452.74it/s]
| Epoch: 10 | Train Loss: 1.297 | Train Acc: 76.17% | Val. Loss: 1.492 | Val. Acc: 53.12% |
100%   320/320 [00:00<00:00, 452.59it/s]
| Epoch: 11 | Train Loss: 1.294 | Train Acc: 76.41% | Val. Loss: 1.500 | Val. Acc: 53.12% |
100%   320/320 [00:00<00:00, 521.25it/s]
| Epoch: 12 | Train Loss: 1.292 | Train Acc: 76.41% | Val. Loss: 1.495 | Val. Acc: 55.00% |
100%   320/320 [00:00<00:00, 449.61it/s]
| Epoch: 13 | Train Loss: 1.294 | Train Acc: 76.33% | Val. Loss: 1.504 | Val. Acc: 53.12% |
100%   320/320 [00:00<00:00, 438.27it/s]
| Epoch: 14 | Train Loss: 1.290 | Train Acc: 76.80% | Val. Loss: 1.500 | Val. Acc: 53.12% |
100%   320/320 [00:00<00:00, 437.99it/s]
| Epoch: 15 | Train Loss: 1.290 | Train Acc: 76.41% | Val. Loss: 1.499 | Val. Acc: 54.37% |
100%   320/320 [00:00<00:00, 615.92it/s]
| Epoch: 16 | Train Loss: 1.289 | Train Acc: 76.64% | Val. Loss: 1.496 | Val. Acc: 53.12% |
100%   320/320 [00:00<00:00, 614.08it/s]
| Epoch: 17 | Train Loss: 1.288 | Train Acc: 76.72% | Val. Loss: 1.496 | Val. Acc: 53.75% |
100%   320/320 [00:00<00:00, 635.66it/s]
| Epoch: 18 | Train Loss: 1.288 | Train Acc: 76.64% | Val. Loss: 1.500 | Val. Acc: 52.50% |
100%   320/320 [00:00<00:00, 535.65it/s]
| Epoch: 19 | Train Loss: 1.288 | Train Acc: 77.03% | Val. Loss: 1.500 | Val. Acc: 53.12% |
100%   320/320 [00:00<00:00, 664.54it/s]
| Epoch: 20 | Train Loss: 1.286 | Train Acc: 77.11% | Val. Loss: 1.495 | Val. Acc: 53.75% |
100%   320/320 [00:00<00:00, 543.93it/s]
| Epoch: 21 | Train Loss: 1.287 | Train Acc: 77.11% | Val. Loss: 1.503 | Val. Acc: 52.50% |
100%   320/320 [00:00<00:00, 549.36it/s]
| Epoch: 22 | Train Loss: 1.285 | Train Acc: 77.27% | Val. Loss: 1.493 | Val. Acc: 53.75% |
100%   320/320 [00:00<00:00, 606.76it/s]
| Epoch: 23 | Train Loss: 1.287 | Train Acc: 77.11% | Val. Loss: 1.495 | Val. Acc: 53.12% |
100%   320/320 [00:00<00:00, 576.88it/s]
| Epoch: 24 | Train Loss: 1.286 | Train Acc: 77.19% | Val. Loss: 1.495 | Val. Acc: 53.75% |
100%   320/320 [00:00<00:00, 670.08it/s]
| Epoch: 25 | Train Loss: 1.284 | Train Acc: 77.27% | Val. Loss: 1.489 | Val. Acc: 53.75% |
100%   320/320 [00:00<00:00, 447.65it/s]
| Epoch: 26 | Train Loss: 1.285 | Train Acc: 77.11% | Val. Loss: 1.492 | Val. Acc: 53.75% |
100%   320/320 [00:00<00:00, 547.48it/s]
| Epoch: 27 | Train Loss: 1.287 | Train Acc: 76.72% | Val. Loss: 1.495 | Val. Acc: 54.37% |
100%   320/320 [00:00<00:00, 654.15it/s]
| Epoch: 28 | Train Loss: 1.283 | Train Acc: 77.34% | Val. Loss: 1.492 | Val. Acc: 53.75% |
100%   320/320 [00:00<00:00, 469.31it/s]
| Epoch: 29 | Train Loss: 1.282 | Train Acc: 77.42% | Val. Loss: 1.487 | Val. Acc: 55.00% |
100%   320/320 [00:00<00:00, 563.20it/s]

```
| Epoch: 30 | Train Loss: 1.281 | Train Acc: 77.34% | Val. Loss: 1.492 | Val. Acc: 53.75% |
100%                              320/320 [00:00<00:00, 553.35it/s]
| Epoch: 31 | Train Loss: 1.282 | Train Acc: 77.58% | Val. Loss: 1.483 | Val. Acc: 55.62% |
100%                              320/320 [00:00<00:00, 453.57it/s]
| Epoch: 32 | Train Loss: 1.283 | Train Acc: 77.27% | Val. Loss: 1.490 | Val. Acc: 54.37% |
100%                              320/320 [00:00<00:00, 428.72it/s]
| Epoch: 33 | Train Loss: 1.282 | Train Acc: 77.42% | Val. Loss: 1.492 | Val. Acc: 53.75% |
100%                              320/320 [00:00<00:00, 446.38it/s]
| Epoch: 34 | Train Loss: 1.280 | Train Acc: 77.66% | Val. Loss: 1.496 | Val. Acc: 53.12% |
100%                              320/320 [00:00<00:00, 406.37it/s]
| Epoch: 35 | Train Loss: 1.281 | Train Acc: 77.42% | Val. Loss: 1.491 | Val. Acc: 53.75% |
100%                              320/320 [00:00<00:00, 436.74it/s]
| Epoch: 36 | Train Loss: 1.281 | Train Acc: 77.50% | Val. Loss: 1.488 | Val. Acc: 54.37% |
100%                              320/320 [00:00<00:00, 492.20it/s]
| Epoch: 37 | Train Loss: 1.278 | Train Acc: 77.73% | Val. Loss: 1.492 | Val. Acc: 53.75% |
100%                              320/320 [00:00<00:00, 512.20it/s]
| Epoch: 38 | Train Loss: 1.278 | Train Acc: 77.66% | Val. Loss: 1.477 | Val. Acc: 55.62% |
100%                              320/320 [00:01<00:00, 222.10it/s]
| Epoch: 39 | Train Loss: 1.280 | Train Acc: 77.66% | Val. Loss: 1.481 | Val. Acc: 55.00% |
100%                              320/320 [00:01<00:00, 226.02it/s]
| Epoch: 40 | Train Loss: 1.277 | Train Acc: 77.58% | Val. Loss: 1.483 | Val. Acc: 55.00% |
100%                              320/320 [00:01<00:00, 283.61it/s]
| Epoch: 41 | Train Loss: 1.280 | Train Acc: 77.58% | Val. Loss: 1.489 | Val. Acc: 55.00% |
100%                              320/320 [00:01<00:00, 210.02it/s]
| Epoch: 42 | Train Loss: 1.281 | Train Acc: 77.42% | Val. Loss: 1.476 | Val. Acc: 56.88% |
100%                              320/320 [00:01<00:00, 275.82it/s]
| Epoch: 43 | Train Loss: 1.276 | Train Acc: 77.73% | Val. Loss: 1.471 | Val. Acc: 57.50% |
100%                              320/320 [00:01<00:00, 276.21it/s]
| Epoch: 44 | Train Loss: 1.280 | Train Acc: 77.73% | Val. Loss: 1.476 | Val. Acc: 57.50% |
100%                              320/320 [00:02<00:00, 174.48it/s]
| Epoch: 45 | Train Loss: 1.277 | Train Acc: 77.81% | Val. Loss: 1.476 | Val. Acc: 56.88% |
100%                              320/320 [00:02<00:00, 113.00it/s]
| Epoch: 46 | Train Loss: 1.276 | Train Acc: 77.89% | Val. Loss: 1.474 | Val. Acc: 55.62% |
100%                              320/320 [00:01<00:00, 268.77it/s]
| Epoch: 47 | Train Loss: 1.276 | Train Acc: 77.89% | Val. Loss: 1.478 | Val. Acc: 56.25% |
100%                              320/320 [00:01<00:00, 239.91it/s]
| Epoch: 48 | Train Loss: 1.275 | Train Acc: 77.97% | Val. Loss: 1.479 | Val. Acc: 56.88% |
100%                              320/320 [00:01<00:00, 212.68it/s]
| Epoch: 49 | Train Loss: 1.273 | Train Acc: 78.05% | Val. Loss: 1.481 | Val. Acc: 55.00% |
100%                              320/320 [00:01<00:00, 238.98it/s]
| Epoch: 50 | Train Loss: 1.273 | Train Acc: 78.12% | Val. Loss: 1.479 | Val. Acc: 56.25% |
100%                              320/320 [00:01<00:00, 237.37it/s]
| Epoch: 51 | Train Loss: 1.273 | Train Acc: 78.20% | Val. Loss: 1.475 | Val. Acc: 56.88% |
100%                              320/320 [00:01<00:00, 210.85it/s]
| Epoch: 52 | Train Loss: 1.275 | Train Acc: 77.89% | Val. Loss: 1.478 | Val. Acc: 56.25% |
100%                              320/320 [00:01<00:00, 438.86it/s]
| Epoch: 53 | Train Loss: 1.273 | Train Acc: 78.28% | Val. Loss: 1.472 | Val. Acc: 56.25% |
100%                              320/320 [00:00<00:00, 410.01it/s]
| Epoch: 54 | Train Loss: 1.271 | Train Acc: 78.52% | Val. Loss: 1.483 | Val. Acc: 55.62% |
100%                              320/320 [00:00<00:00, 424.61it/s]
| Epoch: 55 | Train Loss: 1.271 | Train Acc: 78.36% | Val. Loss: 1.476 | Val. Acc: 56.25% |
100%                              320/320 [00:00<00:00, 374.83it/s]
| Epoch: 56 | Train Loss: 1.269 | Train Acc: 78.52% | Val. Loss: 1.476 | Val. Acc: 56.88% |
100%                              320/320 [00:00<00:00, 366.78it/s]
| Epoch: 57 | Train Loss: 1.270 | Train Acc: 78.28% | Val. Loss: 1.474 | Val. Acc: 56.25% |
100%                              320/320 [00:00<00:00, 377.25it/s]
| Epoch: 58 | Train Loss: 1.270 | Train Acc: 78.36% | Val. Loss: 1.475 | Val. Acc: 55.62% |
100%                              320/320 [00:00<00:00, 568.11it/s]
| Epoch: 59 | Train Loss: 1.273 | Train Acc: 78.20% | Val. Loss: 1.483 | Val. Acc: 55.62% |
100%                              320/320 [00:00<00:00, 590.31it/s]
```

| Epoch: 60 | Train Loss: 1.271 | Train Acc: 78.36% | Val. Loss: 1.477 | Val. Acc: 56.88% |
100%   320/320 [00:00<00:00, 512.61it/s]
| Epoch: 61 | Train Loss: 1.268 | Train Acc: 78.59% | Val. Loss: 1.473 | Val. Acc: 56.88% |
100%   320/320 [00:00<00:00, 631.42it/s]
| Epoch: 62 | Train Loss: 1.269 | Train Acc: 78.36% | Val. Loss: 1.474 | Val. Acc: 56.88% |
100%   320/320 [00:00<00:00, 487.55it/s]
| Epoch: 63 | Train Loss: 1.269 | Train Acc: 78.52% | Val. Loss: 1.476 | Val. Acc: 56.25% |
100%   320/320 [00:00<00:00, 490.20it/s]
| Epoch: 64 | Train Loss: 1.273 | Train Acc: 77.81% | Val. Loss: 1.483 | Val. Acc: 55.62% |
100%   320/320 [00:00<00:00, 641.52it/s]
| Epoch: 65 | Train Loss: 1.274 | Train Acc: 78.05% | Val. Loss: 1.474 | Val. Acc: 56.88% |
100%   320/320 [00:00<00:00, 513.97it/s]
| Epoch: 66 | Train Loss: 1.270 | Train Acc: 78.20% | Val. Loss: 1.478 | Val. Acc: 56.25% |
100%   320/320 [00:00<00:00, 521.45it/s]
| Epoch: 67 | Train Loss: 1.270 | Train Acc: 78.36% | Val. Loss: 1.475 | Val. Acc: 55.00% |
100%   320/320 [00:00<00:00, 589.47it/s]
| Epoch: 68 | Train Loss: 1.269 | Train Acc: 78.28% | Val. Loss: 1.480 | Val. Acc: 56.25% |
100%   320/320 [00:00<00:00, 547.08it/s]
| Epoch: 69 | Train Loss: 1.268 | Train Acc: 78.52% | Val. Loss: 1.474 | Val. Acc: 56.88% |
100%   320/320 [00:00<00:00, 581.81it/s]
| Epoch: 70 | Train Loss: 1.265 | Train Acc: 78.75% | Val. Loss: 1.470 | Val. Acc: 56.88% |
100%   320/320 [00:00<00:00, 570.08it/s]
| Epoch: 71 | Train Loss: 1.266 | Train Acc: 78.67% | Val. Loss: 1.460 | Val. Acc: 56.88% |
100%   320/320 [00:00<00:00, 528.44it/s]
| Epoch: 72 | Train Loss: 1.271 | Train Acc: 78.36% | Val. Loss: 1.464 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 582.89it/s]
| Epoch: 73 | Train Loss: 1.267 | Train Acc: 78.59% | Val. Loss: 1.464 | Val. Acc: 56.88% |
100%   320/320 [00:00<00:00, 486.84it/s]
| Epoch: 74 | Train Loss: 1.268 | Train Acc: 78.44% | Val. Loss: 1.468 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 441.51it/s]
| Epoch: 75 | Train Loss: 1.269 | Train Acc: 78.52% | Val. Loss: 1.471 | Val. Acc: 56.88% |
100%   320/320 [00:00<00:00, 410.09it/s]
| Epoch: 76 | Train Loss: 1.267 | Train Acc: 78.59% | Val. Loss: 1.471 | Val. Acc: 55.62% |
100%   320/320 [00:00<00:00, 369.16it/s]
| Epoch: 77 | Train Loss: 1.268 | Train Acc: 78.44% | Val. Loss: 1.472 | Val. Acc: 56.25% |
100%   320/320 [00:00<00:00, 376.79it/s]
| Epoch: 78 | Train Loss: 1.267 | Train Acc: 78.36% | Val. Loss: 1.467 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 366.97it/s]
| Epoch: 79 | Train Loss: 1.268 | Train Acc: 78.44% | Val. Loss: 1.472 | Val. Acc: 56.88% |
100%   320/320 [00:00<00:00, 575.85it/s]
| Epoch: 80 | Train Loss: 1.266 | Train Acc: 78.67% | Val. Loss: 1.465 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 475.41it/s]
| Epoch: 81 | Train Loss: 1.264 | Train Acc: 78.75% | Val. Loss: 1.465 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 557.67it/s]
| Epoch: 82 | Train Loss: 1.262 | Train Acc: 79.14% | Val. Loss: 1.465 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 610.51it/s]
| Epoch: 83 | Train Loss: 1.267 | Train Acc: 78.67% | Val. Loss: 1.457 | Val. Acc: 58.75% |
100%   320/320 [00:00<00:00, 485.28it/s]
| Epoch: 84 | Train Loss: 1.263 | Train Acc: 78.98% | Val. Loss: 1.468 | Val. Acc: 56.88% |
100%   320/320 [00:00<00:00, 554.83it/s]
| Epoch: 85 | Train Loss: 1.263 | Train Acc: 78.98% | Val. Loss: 1.469 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 543.76it/s]
| Epoch: 86 | Train Loss: 1.263 | Train Acc: 78.83% | Val. Loss: 1.464 | Val. Acc: 58.13% |
100%   320/320 [00:00<00:00, 593.99it/s]
| Epoch: 87 | Train Loss: 1.262 | Train Acc: 79.06% | Val. Loss: 1.463 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 569.12it/s]
| Epoch: 88 | Train Loss: 1.262 | Train Acc: 79.14% | Val. Loss: 1.463 | Val. Acc: 58.13% |
100%   320/320 [00:00<00:00, 552.57it/s]
| Epoch: 89 | Train Loss: 1.264 | Train Acc: 78.91% | Val. Loss: 1.471 | Val. Acc: 58.75% |

```
100%                                      320/320 [00:00<00:00, 573.84it/s]
| Epoch: 90 | Train Loss: 1.266 | Train Acc: 78.59% | Val. Loss: 1.466 | Val. Acc: 57.50% |
100%                                      320/320 [00:00<00:00, 622.04it/s]
| Epoch: 91 | Train Loss: 1.264 | Train Acc: 78.75% | Val. Loss: 1.466 | Val. Acc: 57.50% |
100%                                      320/320 [00:00<00:00, 525.15it/s]
| Epoch: 92 | Train Loss: 1.266 | Train Acc: 78.83% | Val. Loss: 1.467 | Val. Acc: 57.50% |
100%                                      320/320 [00:00<00:00, 530.74it/s]
| Epoch: 93 | Train Loss: 1.262 | Train Acc: 79.22% | Val. Loss: 1.463 | Val. Acc: 56.88% |
100%                                      320/320 [00:00<00:00, 588.45it/s]
| Epoch: 94 | Train Loss: 1.260 | Train Acc: 79.14% | Val. Loss: 1.466 | Val. Acc: 56.88% |
100%                                      320/320 [00:00<00:00, 455.05it/s]
| Epoch: 95 | Train Loss: 1.260 | Train Acc: 79.22% | Val. Loss: 1.466 | Val. Acc: 57.50% |
100%                                      320/320 [00:00<00:00, 406.41it/s]
| Epoch: 96 | Train Loss: 1.261 | Train Acc: 79.22% | Val. Loss: 1.462 | Val. Acc: 57.50% |
100%                                      320/320 [00:00<00:00, 459.70it/s]
| Epoch: 97 | Train Loss: 1.260 | Train Acc: 79.22% | Val. Loss: 1.466 | Val. Acc: 57.50% |
100%                                      320/320 [00:00<00:00, 537.92it/s]
| Epoch: 98 | Train Loss: 1.262 | Train Acc: 79.14% | Val. Loss: 1.477 | Val. Acc: 56.25% |
100%                                      320/320 [00:00<00:00, 443.14it/s]
| Epoch: 99 | Train Loss: 1.262 | Train Acc: 79.14% | Val. Loss: 1.464 | Val. Acc: 56.88% |
100%                                      320/320 [00:00<00:00, 454.14it/s]
| Epoch: 100 | Train Loss: 1.260 | Train Acc: 79.14% | Val. Loss: 1.470 | Val. Acc: 56.25% |
| Test Loss: 1.405 | Test Acc: 64.17% |
```

```python
from sklearn.metrics import precision_score, recall_score, f1_score

# Modify the test evaluation function to store predictions and true labels
def test_evaluate(model, data_loader, criterion):
    epoch_loss = 0
    epoch_acc = 0
    all_preds = []
    all_labels = []

    model.eval()
    with torch.no_grad():
        for d in data_loader:
            inputs = d['features'].to(device)
            labels = d['labels'].to(device)
            outputs = model(inputs)

            _, preds = torch.max(outputs, dim=1)
            loss = criterion(outputs, labels)
            acc = accuracy(outputs, labels)

            epoch_loss += loss.item()
            epoch_acc += acc.item()

            # Collect predictions and labels for metric calculation
            all_preds.extend(preds.cpu().numpy())
            all_labels.extend(labels.cpu().numpy())

    # Calculate precision, recall, and F1-score
    precision = precision_score(all_labels, all_preds, average='weighted')
    recall = recall_score(all_labels, all_preds, average='weighted')
    f1 = f1_score(all_labels, all_preds, average='weighted')

    return epoch_loss / len(data_loader), epoch_acc / len(data_loader), precision, recall, f1

# After training, evaluate on the test set
test_loss, test_acc, precision, recall, f1 = test_evaluate(winemodel, test_dataloader, criterion)

print(f'| Test Loss: {test_loss:.3f} | Test Acc: {test_acc*100:.2f}% | Precision: {precision:.2f} | Recall: {recall:.2f} | F1-score: {f1:.2f
```

```
| Test Loss: 1.405 | Test Acc: 64.17% | Precision: 0.61 | Recall: 0.64 | F1-score: 0.62 |
/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1471: UndefinedMetricWarning: Precision is ill-defined and be
  _warn_prf(average, modifier, msg_start, len(result))
```

Enhancement 2: Increase the number of epochs (and maybe the learning rate). Does the accuracy on the test set increase? Is there a significant difference between the test accuracy and the train accuracy? If yes, why?

Did the accuracy on the test set increase after increasing the number of epochs and adjusting the learning rate?

- The test accuracy reported at the end is **58.33%**, which is slightly higher than the validation accuracy during the training epochs. This indicates that the model improved slightly on the test set but not dramatically. The accuracy fluctuates around similar values during the final epochs, which suggests that further increasing the number of epochs may not significantly improve performance.

Is there a significant difference between the test accuracy and the train accuracy? If yes, why?

- **Yes**, there is a noticeable difference between the training accuracy (around **69% to 71%**) and the test accuracy (**58.33%**).
- This gap suggests **overfitting**. The model performs better on the training data compared to unseen data (the test set). Overfitting occurs when the model memorizes or becomes too specialized in the training set, making it less capable of generalizing to new data.

```python
from torch.optim import Adam  # Import Adam optimizer


# Modify the optimizer to use a new learning rate
optimizer = Adam(winemodel.parameters(), lr=5e-3)  # Experiment with this value, start with a slightly higher LR

# Increase the number of epochs to 200
num_epochs = 200
```

```python
for epoch in range(num_epochs):
    train_loss, train_acc = train(winemodel, train_dataloader, optimizer, criterion)
    valid_loss, valid_acc = evaluate(winemodel, val_dataloader, criterion)

    print(f'| Epoch: {epoch+1:02} | Train Loss: {train_loss:.3f} | Train Acc: {train_acc*100:.2f}% | Val. Loss: {valid_loss:.3f} | Val. Acc:

# Evaluate on the test set
test_loss, test_acc = test_evaluate(winemodel, test_dataloader, criterion)

print(f'| Test Loss: {test_loss:.3f} | Test Acc: {test_acc*100:.2f}% |')
```

100%   320/320 [00:00<00:00, 679.75it/s]
| Epoch: 01 | Train Loss: 1.374 | Train Acc: 67.11% | Val. Loss: 1.471 | Val. Acc: 56.88% |
100%   320/320 [00:00<00:00, 554.93it/s]
| Epoch: 02 | Train Loss: 1.381 | Train Acc: 66.17% | Val. Loss: 1.462 | Val. Acc: 59.38% |
100%   320/320 [00:00<00:00, 657.63it/s]
| Epoch: 03 | Train Loss: 1.379 | Train Acc: 66.41% | Val. Loss: 1.478 | Val. Acc: 55.00% |
100%   320/320 [00:00<00:00, 691.66it/s]
| Epoch: 04 | Train Loss: 1.399 | Train Acc: 64.30% | Val. Loss: 1.465 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 675.80it/s]
| Epoch: 05 | Train Loss: 1.402 | Train Acc: 63.98% | Val. Loss: 1.499 | Val. Acc: 53.75% |
100%   320/320 [00:00<00:00, 559.75it/s]
| Epoch: 06 | Train Loss: 1.412 | Train Acc: 63.05% | Val. Loss: 1.524 | Val. Acc: 51.88% |
100%   320/320 [00:00<00:00, 675.43it/s]
| Epoch: 07 | Train Loss: 1.404 | Train Acc: 63.91% | Val. Loss: 1.520 | Val. Acc: 51.88% |
100%   320/320 [00:00<00:00, 704.84it/s]
| Epoch: 08 | Train Loss: 1.392 | Train Acc: 65.08% | Val. Loss: 1.521 | Val. Acc: 52.50% |
100%   320/320 [00:00<00:00, 568.53it/s]
| Epoch: 09 | Train Loss: 1.393 | Train Acc: 65.08% | Val. Loss: 1.540 | Val. Acc: 49.38% |
100%   320/320 [00:00<00:00, 564.34it/s]
| Epoch: 10 | Train Loss: 1.384 | Train Acc: 65.86% | Val. Loss: 1.512 | Val. Acc: 51.88% |
100%   320/320 [00:00<00:00, 664.31it/s]
| Epoch: 11 | Train Loss: 1.399 | Train Acc: 64.38% | Val. Loss: 1.484 | Val. Acc: 55.00% |
100%   320/320 [00:00<00:00, 713.74it/s]
| Epoch: 12 | Train Loss: 1.382 | Train Acc: 65.86% | Val. Loss: 1.514 | Val. Acc: 52.50% |
100%   320/320 [00:00<00:00, 552.87it/s]
| Epoch: 13 | Train Loss: 1.382 | Train Acc: 66.17% | Val. Loss: 1.499 | Val. Acc: 55.00% |
100%   320/320 [00:00<00:00, 561.97it/s]
| Epoch: 14 | Train Loss: 1.385 | Train Acc: 65.47% | Val. Loss: 1.518 | Val. Acc: 51.88% |
100%   320/320 [00:00<00:00, 543.72it/s]
| Epoch: 15 | Train Loss: 1.392 | Train Acc: 65.08% | Val. Loss: 1.494 | Val. Acc: 55.00% |
100%   320/320 [00:00<00:00, 384.93it/s]
| Epoch: 16 | Train Loss: 1.383 | Train Acc: 65.86% | Val. Loss: 1.491 | Val. Acc: 55.00% |
100%   320/320 [00:00<00:00, 439.40it/s]
| Epoch: 17 | Train Loss: 1.401 | Train Acc: 63.83% | Val. Loss: 1.486 | Val. Acc: 55.62% |
100%   320/320 [00:00<00:00, 369.52it/s]
| Epoch: 18 | Train Loss: 1.376 | Train Acc: 66.80% | Val. Loss: 1.471 | Val. Acc: 56.88% |
100%   320/320 [00:00<00:00, 489.88it/s]
| Epoch: 19 | Train Loss: 1.376 | Train Acc: 66.80% | Val. Loss: 1.483 | Val. Acc: 56.25% |
100%   320/320 [00:00<00:00, 701.86it/s]
| Epoch: 20 | Train Loss: 1.377 | Train Acc: 66.41% | Val. Loss: 1.483 | Val. Acc: 55.62% |
100%   320/320 [00:00<00:00, 610.29it/s]
| Epoch: 21 | Train Loss: 1.376 | Train Acc: 66.64% | Val. Loss: 1.485 | Val. Acc: 55.62% |
100%   320/320 [00:00<00:00, 555.69it/s]
| Epoch: 22 | Train Loss: 1.375 | Train Acc: 66.64% | Val. Loss: 1.493 | Val. Acc: 54.37% |
100%   320/320 [00:00<00:00, 664.90it/s]
| Epoch: 23 | Train Loss: 1.391 | Train Acc: 65.08% | Val. Loss: 1.492 | Val. Acc: 54.37% |
100%   320/320 [00:00<00:00, 690.93it/s]
| Epoch: 24 | Train Loss: 1.396 | Train Acc: 64.53% | Val. Loss: 1.494 | Val. Acc: 55.00% |
100%   320/320 [00:00<00:00, 542.02it/s]
| Epoch: 25 | Train Loss: 1.397 | Train Acc: 64.69% | Val. Loss: 1.490 | Val. Acc: 54.37% |
100%   320/320 [00:00<00:00, 643.60it/s]
| Epoch: 26 | Train Loss: 1.388 | Train Acc: 65.31% | Val. Loss: 1.508 | Val. Acc: 53.12% |
100%   320/320 [00:00<00:00, 666.12it/s]
| Epoch: 27 | Train Loss: 1.376 | Train Acc: 66.80% | Val. Loss: 1.507 | Val. Acc: 53.12% |
100%   320/320 [00:00<00:00, 591.27it/s]
| Epoch: 28 | Train Loss: 1.390 | Train Acc: 65.23% | Val. Loss: 1.522 | Val. Acc: 51.25% |
100%   320/320 [00:00<00:00, 698.08it/s]
| Epoch: 29 | Train Loss: 1.376 | Train Acc: 66.56% | Val. Loss: 1.523 | Val. Acc: 51.25% |
100%   320/320 [00:00<00:00, 567.63it/s]

```
| Epoch: 30 | Train Loss: 1.377 | Train Acc: 66.25% | Val. Loss: 1.484 | Val. Acc: 56.25% |
100%                                  320/320 [00:00<00:00, 670.45it/s]
| Epoch: 31 | Train Loss: 1.365 | Train Acc: 67.81% | Val. Loss: 1.481 | Val. Acc: 57.50% |
100%                                  320/320 [00:00<00:00, 523.09it/s]
| Epoch: 32 | Train Loss: 1.369 | Train Acc: 67.50% | Val. Loss: 1.505 | Val. Acc: 53.12% |
100%                                  320/320 [00:00<00:00, 617.50it/s]
| Epoch: 33 | Train Loss: 1.382 | Train Acc: 65.94% | Val. Loss: 1.505 | Val. Acc: 53.75% |
100%                                  320/320 [00:00<00:00, 640.71it/s]
| Epoch: 34 | Train Loss: 1.369 | Train Acc: 67.34% | Val. Loss: 1.510 | Val. Acc: 53.75% |
100%                                  320/320 [00:00<00:00, 570.77it/s]
| Epoch: 35 | Train Loss: 1.370 | Train Acc: 67.34% | Val. Loss: 1.473 | Val. Acc: 56.88% |
100%                                  320/320 [00:00<00:00, 654.83it/s]
| Epoch: 36 | Train Loss: 1.384 | Train Acc: 65.86% | Val. Loss: 1.465 | Val. Acc: 58.13% |
100%                                  320/320 [00:00<00:00, 445.85it/s]
| Epoch: 37 | Train Loss: 1.382 | Train Acc: 66.17% | Val. Loss: 1.491 | Val. Acc: 55.00% |
100%                                  320/320 [00:00<00:00, 412.87it/s]
| Epoch: 38 | Train Loss: 1.379 | Train Acc: 66.41% | Val. Loss: 1.484 | Val. Acc: 55.62% |
100%                                  320/320 [00:00<00:00, 384.15it/s]
| Epoch: 39 | Train Loss: 1.368 | Train Acc: 67.58% | Val. Loss: 1.524 | Val. Acc: 50.62% |
100%                                  320/320 [00:00<00:00, 437.75it/s]
| Epoch: 40 | Train Loss: 1.363 | Train Acc: 67.97% | Val. Loss: 1.485 | Val. Acc: 56.25% |
100%                                  320/320 [00:00<00:00, 547.25it/s]
| Epoch: 41 | Train Loss: 1.376 | Train Acc: 66.95% | Val. Loss: 1.515 | Val. Acc: 53.12% |
100%                                  320/320 [00:00<00:00, 591.43it/s]
| Epoch: 42 | Train Loss: 1.377 | Train Acc: 66.64% | Val. Loss: 1.495 | Val. Acc: 55.00% |
100%                                  320/320 [00:00<00:00, 701.60it/s]
| Epoch: 43 | Train Loss: 1.363 | Train Acc: 68.20% | Val. Loss: 1.511 | Val. Acc: 53.75% |
100%                                  320/320 [00:00<00:00, 549.59it/s]
| Epoch: 44 | Train Loss: 1.370 | Train Acc: 67.27% | Val. Loss: 1.497 | Val. Acc: 54.37% |
100%                                  320/320 [00:00<00:00, 600.99it/s]
| Epoch: 45 | Train Loss: 1.371 | Train Acc: 67.27% | Val. Loss: 1.489 | Val. Acc: 55.62% |
100%                                  320/320 [00:00<00:00, 590.06it/s]
| Epoch: 46 | Train Loss: 1.367 | Train Acc: 67.66% | Val. Loss: 1.511 | Val. Acc: 52.50% |
100%                                  320/320 [00:00<00:00, 590.03it/s]
| Epoch: 47 | Train Loss: 1.367 | Train Acc: 67.66% | Val. Loss: 1.523 | Val. Acc: 51.88% |
100%                                  320/320 [00:00<00:00, 671.42it/s]
| Epoch: 48 | Train Loss: 1.369 | Train Acc: 67.34% | Val. Loss: 1.516 | Val. Acc: 51.88% |
100%                                  320/320 [00:00<00:00, 535.85it/s]
| Epoch: 49 | Train Loss: 1.361 | Train Acc: 68.36% | Val. Loss: 1.484 | Val. Acc: 55.00% |
100%                                  320/320 [00:00<00:00, 614.00it/s]
| Epoch: 50 | Train Loss: 1.371 | Train Acc: 67.27% | Val. Loss: 1.512 | Val. Acc: 52.50% |
100%                                  320/320 [00:00<00:00, 594.21it/s]
| Epoch: 51 | Train Loss: 1.370 | Train Acc: 67.19% | Val. Loss: 1.498 | Val. Acc: 54.37% |
100%                                  320/320 [00:00<00:00, 592.37it/s]
| Epoch: 52 | Train Loss: 1.359 | Train Acc: 68.36% | Val. Loss: 1.471 | Val. Acc: 56.88% |
100%                                  320/320 [00:00<00:00, 684.01it/s]
| Epoch: 53 | Train Loss: 1.363 | Train Acc: 68.12% | Val. Loss: 1.467 | Val. Acc: 57.50% |
100%                                  320/320 [00:00<00:00, 542.44it/s]
| Epoch: 54 | Train Loss: 1.367 | Train Acc: 67.58% | Val. Loss: 1.494 | Val. Acc: 55.00% |
100%                                  320/320 [00:00<00:00, 682.59it/s]
| Epoch: 55 | Train Loss: 1.371 | Train Acc: 67.27% | Val. Loss: 1.483 | Val. Acc: 55.62% |
100%                                  320/320 [00:00<00:00, 592.09it/s]
| Epoch: 56 | Train Loss: 1.368 | Train Acc: 67.58% | Val. Loss: 1.469 | Val. Acc: 57.50% |
100%                                  320/320 [00:00<00:00, 571.13it/s]
| Epoch: 57 | Train Loss: 1.359 | Train Acc: 68.44% | Val. Loss: 1.465 | Val. Acc: 58.13% |
100%                                  320/320 [00:00<00:00, 475.99it/s]
| Epoch: 58 | Train Loss: 1.363 | Train Acc: 68.20% | Val. Loss: 1.475 | Val. Acc: 56.88% |
100%                                  320/320 [00:00<00:00, 482.20it/s]
| Epoch: 59 | Train Loss: 1.377 | Train Acc: 66.64% | Val. Loss: 1.474 | Val. Acc: 56.88% |
100%                                  320/320 [00:00<00:00, 421.96it/s]
```

```
| Epoch: 60 | Train Loss: 1.375 | Train Acc: 66.95% | Val. Loss: 1.484 | Val. Acc: 56.88% |
100%                                              320/320 [00:00<00:00, 368.54it/s]
| Epoch: 61 | Train Loss: 1.375 | Train Acc: 66.64% | Val. Loss: 1.493 | Val. Acc: 54.37% |
100%                                              320/320 [00:00<00:00, 372.28it/s]
| Epoch: 62 | Train Loss: 1.367 | Train Acc: 67.73% | Val. Loss: 1.493 | Val. Acc: 55.62% |
100%                                              320/320 [00:00<00:00, 620.20it/s]
| Epoch: 63 | Train Loss: 1.368 | Train Acc: 67.58% | Val. Loss: 1.467 | Val. Acc: 57.50% |
100%                                              320/320 [00:00<00:00, 590.99it/s]
| Epoch: 64 | Train Loss: 1.353 | Train Acc: 69.22% | Val. Loss: 1.465 | Val. Acc: 57.50% |
100%                                              320/320 [00:00<00:00, 645.28it/s]
| Epoch: 65 | Train Loss: 1.354 | Train Acc: 68.91% | Val. Loss: 1.467 | Val. Acc: 57.50% |
100%                                              320/320 [00:00<00:00, 563.33it/s]
| Epoch: 66 | Train Loss: 1.353 | Train Acc: 69.06% | Val. Loss: 1.471 | Val. Acc: 56.88% |
100%                                              320/320 [00:00<00:00, 523.54it/s]
| Epoch: 67 | Train Loss: 1.348 | Train Acc: 69.53% | Val. Loss: 1.466 | Val. Acc: 57.50% |
100%                                              320/320 [00:00<00:00, 667.80it/s]
| Epoch: 68 | Train Loss: 1.344 | Train Acc: 70.00% | Val. Loss: 1.481 | Val. Acc: 55.62% |
100%                                              320/320 [00:00<00:00, 539.18it/s]
| Epoch: 69 | Train Loss: 1.346 | Train Acc: 69.77% | Val. Loss: 1.458 | Val. Acc: 58.75% |
100%                                              320/320 [00:00<00:00, 612.40it/s]
| Epoch: 70 | Train Loss: 1.348 | Train Acc: 69.61% | Val. Loss: 1.457 | Val. Acc: 59.38% |
100%                                              320/320 [00:00<00:00, 619.69it/s]
| Epoch: 71 | Train Loss: 1.344 | Train Acc: 70.08% | Val. Loss: 1.482 | Val. Acc: 55.62% |
100%                                              320/320 [00:00<00:00, 513.94it/s]
| Epoch: 72 | Train Loss: 1.357 | Train Acc: 68.67% | Val. Loss: 1.476 | Val. Acc: 56.25% |
100%                                              320/320 [00:00<00:00, 674.83it/s]
| Epoch: 73 | Train Loss: 1.355 | Train Acc: 68.83% | Val. Loss: 1.473 | Val. Acc: 56.88% |
100%                                              320/320 [00:00<00:00, 541.79it/s]
| Epoch: 74 | Train Loss: 1.352 | Train Acc: 69.14% | Val. Loss: 1.512 | Val. Acc: 53.12% |
100%                                              320/320 [00:00<00:00, 578.83it/s]
| Epoch: 75 | Train Loss: 1.360 | Train Acc: 68.20% | Val. Loss: 1.481 | Val. Acc: 55.62% |
100%                                              320/320 [00:00<00:00, 618.02it/s]
| Epoch: 76 | Train Loss: 1.352 | Train Acc: 69.30% | Val. Loss: 1.450 | Val. Acc: 60.00% |
100%                                              320/320 [00:00<00:00, 559.02it/s]
| Epoch: 77 | Train Loss: 1.361 | Train Acc: 68.20% | Val. Loss: 1.486 | Val. Acc: 55.00% |
100%                                              320/320 [00:00<00:00, 622.10it/s]
| Epoch: 78 | Train Loss: 1.359 | Train Acc: 68.44% | Val. Loss: 1.466 | Val. Acc: 56.88% |
100%                                              320/320 [00:00<00:00, 415.82it/s]
| Epoch: 79 | Train Loss: 1.358 | Train Acc: 68.67% | Val. Loss: 1.448 | Val. Acc: 60.00% |
100%                                              320/320 [00:00<00:00, 423.50it/s]
| Epoch: 80 | Train Loss: 1.356 | Train Acc: 68.59% | Val. Loss: 1.450 | Val. Acc: 59.38% |
100%                                              320/320 [00:00<00:00, 410.20it/s]
| Epoch: 81 | Train Loss: 1.352 | Train Acc: 69.06% | Val. Loss: 1.470 | Val. Acc: 57.50% |
100%                                              320/320 [00:00<00:00, 407.83it/s]
| Epoch: 82 | Train Loss: 1.349 | Train Acc: 69.53% | Val. Loss: 1.467 | Val. Acc: 56.88% |
100%                                              320/320 [00:00<00:00, 406.90it/s]
| Epoch: 83 | Train Loss: 1.338 | Train Acc: 70.70% | Val. Loss: 1.480 | Val. Acc: 56.25% |
100%                                              320/320 [00:00<00:00, 546.07it/s]
| Epoch: 84 | Train Loss: 1.339 | Train Acc: 70.55% | Val. Loss: 1.459 | Val. Acc: 58.13% |
100%                                              320/320 [00:00<00:00, 605.80it/s]
| Epoch: 85 | Train Loss: 1.353 | Train Acc: 68.98% | Val. Loss: 1.472 | Val. Acc: 57.50% |
100%                                              320/320 [00:00<00:00, 627.06it/s]
| Epoch: 86 | Train Loss: 1.350 | Train Acc: 69.22% | Val. Loss: 1.467 | Val. Acc: 58.13% |
100%                                              320/320 [00:00<00:00, 553.24it/s]
| Epoch: 87 | Train Loss: 1.359 | Train Acc: 68.44% | Val. Loss: 1.453 | Val. Acc: 58.75% |
100%                                              320/320 [00:00<00:00, 570.17it/s]
| Epoch: 88 | Train Loss: 1.359 | Train Acc: 68.44% | Val. Loss: 1.440 | Val. Acc: 60.62% |
100%                                              320/320 [00:00<00:00, 691.44it/s]
| Epoch: 89 | Train Loss: 1.348 | Train Acc: 69.61% | Val. Loss: 1.459 | Val. Acc: 58.13% |
```

| Epoch: 90 | Train Loss: 1.339 | Train Acc: 70.47% | Val. Loss: 1.486 | Val. Acc: 55.62% |
100%   320/320 [00:00<00:00, 579.97it/s]
| Epoch: 91 | Train Loss: 1.337 | Train Acc: 70.62% | Val. Loss: 1.458 | Val. Acc: 58.75% |
100%   320/320 [00:00<00:00, 598.53it/s]
| Epoch: 92 | Train Loss: 1.340 | Train Acc: 70.47% | Val. Loss: 1.472 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 561.91it/s]
| Epoch: 93 | Train Loss: 1.365 | Train Acc: 67.97% | Val. Loss: 1.493 | Val. Acc: 55.00% |
100%   320/320 [00:00<00:00, 676.11it/s]
| Epoch: 94 | Train Loss: 1.350 | Train Acc: 69.30% | Val. Loss: 1.464 | Val. Acc: 58.13% |
100%   320/320 [00:00<00:00, 519.38it/s]
| Epoch: 95 | Train Loss: 1.349 | Train Acc: 69.53% | Val. Loss: 1.507 | Val. Acc: 53.75% |
100%   320/320 [00:00<00:00, 569.20it/s]
| Epoch: 96 | Train Loss: 1.354 | Train Acc: 68.83% | Val. Loss: 1.494 | Val. Acc: 55.00% |
100%   320/320 [00:00<00:00, 689.83it/s]
| Epoch: 97 | Train Loss: 1.357 | Train Acc: 68.83% | Val. Loss: 1.485 | Val. Acc: 56.25% |
100%   320/320 [00:00<00:00, 521.03it/s]
| Epoch: 98 | Train Loss: 1.354 | Train Acc: 68.98% | Val. Loss: 1.480 | Val. Acc: 56.88% |
100%   320/320 [00:00<00:00, 580.11it/s]
| Epoch: 99 | Train Loss: 1.350 | Train Acc: 69.45% | Val. Loss: 1.467 | Val. Acc: 58.13% |
100%   320/320 [00:00<00:00, 606.67it/s]
| Epoch: 100 | Train Loss: 1.358 | Train Acc: 68.59% | Val. Loss: 1.485 | Val. Acc: 55.00% |
100%   320/320 [00:00<00:00, 414.48it/s]
| Epoch: 101 | Train Loss: 1.346 | Train Acc: 69.92% | Val. Loss: 1.450 | Val. Acc: 59.38% |
100%   320/320 [00:00<00:00, 403.34it/s]
| Epoch: 102 | Train Loss: 1.358 | Train Acc: 68.59% | Val. Loss: 1.459 | Val. Acc: 58.13% |
100%   320/320 [00:00<00:00, 474.07it/s]
| Epoch: 103 | Train Loss: 1.357 | Train Acc: 68.59% | Val. Loss: 1.455 | Val. Acc: 58.13% |
100%   320/320 [00:00<00:00, 406.07it/s]
| Epoch: 104 | Train Loss: 1.346 | Train Acc: 69.92% | Val. Loss: 1.471 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 410.47it/s]
| Epoch: 105 | Train Loss: 1.352 | Train Acc: 69.14% | Val. Loss: 1.481 | Val. Acc: 55.62% |
100%   320/320 [00:00<00:00, 528.12it/s]
| Epoch: 106 | Train Loss: 1.348 | Train Acc: 69.53% | Val. Loss: 1.464 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 570.74it/s]
| Epoch: 107 | Train Loss: 1.345 | Train Acc: 69.84% | Val. Loss: 1.452 | Val. Acc: 59.38% |
100%   320/320 [00:00<00:00, 621.14it/s]
| Epoch: 108 | Train Loss: 1.344 | Train Acc: 69.92% | Val. Loss: 1.481 | Val. Acc: 55.62% |
100%   320/320 [00:00<00:00, 536.37it/s]
| Epoch: 109 | Train Loss: 1.345 | Train Acc: 69.84% | Val. Loss: 1.483 | Val. Acc: 56.25% |
100%   320/320 [00:00<00:00, 525.68it/s]
| Epoch: 110 | Train Loss: 1.355 | Train Acc: 68.83% | Val. Loss: 1.475 | Val. Acc: 56.88% |
100%   320/320 [00:00<00:00, 642.09it/s]
| Epoch: 111 | Train Loss: 1.341 | Train Acc: 70.39% | Val. Loss: 1.483 | Val. Acc: 55.62% |
100%   320/320 [00:00<00:00, 596.81it/s]
| Epoch: 112 | Train Loss: 1.342 | Train Acc: 70.23% | Val. Loss: 1.484 | Val. Acc: 55.62% |
100%   320/320 [00:00<00:00, 504.71it/s]
| Epoch: 113 | Train Loss: 1.350 | Train Acc: 69.30% | Val. Loss: 1.445 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 620.58it/s]
| Epoch: 114 | Train Loss: 1.349 | Train Acc: 69.53% | Val. Loss: 1.443 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 637.75it/s]
| Epoch: 115 | Train Loss: 1.337 | Train Acc: 70.78% | Val. Loss: 1.466 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 508.00it/s]
| Epoch: 116 | Train Loss: 1.335 | Train Acc: 70.86% | Val. Loss: 1.454 | Val. Acc: 58.75% |
100%   320/320 [00:00<00:00, 599.73it/s]
| Epoch: 117 | Train Loss: 1.334 | Train Acc: 70.94% | Val. Loss: 1.467 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 658.51it/s]
| Epoch: 118 | Train Loss: 1.343 | Train Acc: 70.16% | Val. Loss: 1.465 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 511.79it/s]
| Epoch: 119 | Train Loss: 1.334 | Train Acc: 70.94% | Val. Loss: 1.496 | Val. Acc: 55.00% |

```
100%                                    320/320 [00:00<00:00, 596.20it/s]
| Epoch: 120 | Train Loss: 1.335 | Train Acc: 70.94% | Val. Loss: 1.461 | Val. Acc: 58.13% |
100%                                    320/320 [00:00<00:00, 544.91it/s]
| Epoch: 121 | Train Loss: 1.338 | Train Acc: 70.55% | Val. Loss: 1.480 | Val. Acc: 56.25% |
100%                                    320/320 [00:00<00:00, 406.65it/s]
| Epoch: 122 | Train Loss: 1.353 | Train Acc: 69.14% | Val. Loss: 1.505 | Val. Acc: 53.12% |
100%                                    320/320 [00:00<00:00, 463.36it/s]
| Epoch: 123 | Train Loss: 1.341 | Train Acc: 70.23% | Val. Loss: 1.485 | Val. Acc: 55.62% |
100%                                    320/320 [00:00<00:00, 365.52it/s]
| Epoch: 124 | Train Loss: 1.332 | Train Acc: 71.17% | Val. Loss: 1.484 | Val. Acc: 55.62% |
100%                                    320/320 [00:00<00:00, 374.73it/s]
| Epoch: 125 | Train Loss: 1.333 | Train Acc: 70.94% | Val. Loss: 1.463 | Val. Acc: 58.13% |
100%                                    320/320 [00:00<00:00, 473.86it/s]
| Epoch: 126 | Train Loss: 1.336 | Train Acc: 70.78% | Val. Loss: 1.460 | Val. Acc: 58.13% |
100%                                    320/320 [00:00<00:00, 482.48it/s]
| Epoch: 127 | Train Loss: 1.351 | Train Acc: 69.22% | Val. Loss: 1.483 | Val. Acc: 56.25% |
100%                                    320/320 [00:00<00:00, 595.28it/s]
| Epoch: 128 | Train Loss: 1.328 | Train Acc: 71.48% | Val. Loss: 1.474 | Val. Acc: 56.25% |
100%                                    320/320 [00:00<00:00, 668.02it/s]
| Epoch: 129 | Train Loss: 1.330 | Train Acc: 71.41% | Val. Loss: 1.483 | Val. Acc: 55.62% |
100%                                    320/320 [00:00<00:00, 519.09it/s]
| Epoch: 130 | Train Loss: 1.331 | Train Acc: 71.33% | Val. Loss: 1.462 | Val. Acc: 57.50% |
100%                                    320/320 [00:00<00:00, 562.44it/s]
| Epoch: 131 | Train Loss: 1.347 | Train Acc: 69.77% | Val. Loss: 1.506 | Val. Acc: 53.12% |
100%                                    320/320 [00:00<00:00, 658.77it/s]
| Epoch: 132 | Train Loss: 1.353 | Train Acc: 68.98% | Val. Loss: 1.486 | Val. Acc: 55.62% |
100%                                    320/320 [00:00<00:00, 523.80it/s]
| Epoch: 133 | Train Loss: 1.357 | Train Acc: 68.67% | Val. Loss: 1.488 | Val. Acc: 55.62% |
100%                                    320/320 [00:00<00:00, 584.10it/s]
| Epoch: 134 | Train Loss: 1.340 | Train Acc: 70.39% | Val. Loss: 1.477 | Val. Acc: 56.88% |
100%                                    320/320 [00:00<00:00, 602.16it/s]
| Epoch: 135 | Train Loss: 1.336 | Train Acc: 70.78% | Val. Loss: 1.487 | Val. Acc: 56.25% |
100%                                    320/320 [00:00<00:00, 566.63it/s]
| Epoch: 136 | Train Loss: 1.339 | Train Acc: 70.47% | Val. Loss: 1.485 | Val. Acc: 56.25% |
100%                                    320/320 [00:00<00:00, 632.70it/s]
| Epoch: 137 | Train Loss: 1.342 | Train Acc: 70.16% | Val. Loss: 1.486 | Val. Acc: 55.62% |
100%                                    320/320 [00:00<00:00, 540.18it/s]
| Epoch: 138 | Train Loss: 1.340 | Train Acc: 70.31% | Val. Loss: 1.460 | Val. Acc: 58.75% |
100%                                    320/320 [00:00<00:00, 530.38it/s]
| Epoch: 139 | Train Loss: 1.348 | Train Acc: 69.61% | Val. Loss: 1.481 | Val. Acc: 55.62% |
100%                                    320/320 [00:00<00:00, 509.40it/s]
| Epoch: 140 | Train Loss: 1.339 | Train Acc: 70.47% | Val. Loss: 1.451 | Val. Acc: 59.38% |
100%                                    320/320 [00:00<00:00, 573.37it/s]
| Epoch: 141 | Train Loss: 1.346 | Train Acc: 69.69% | Val. Loss: 1.480 | Val. Acc: 56.88% |
100%                                    320/320 [00:00<00:00, 504.35it/s]
| Epoch: 142 | Train Loss: 1.344 | Train Acc: 69.84% | Val. Loss: 1.470 | Val. Acc: 57.50% |
100%                                    320/320 [00:00<00:00, 352.79it/s]
| Epoch: 143 | Train Loss: 1.339 | Train Acc: 70.39% | Val. Loss: 1.484 | Val. Acc: 55.62% |
100%                                    320/320 [00:00<00:00, 442.32it/s]
| Epoch: 144 | Train Loss: 1.348 | Train Acc: 69.38% | Val. Loss: 1.471 | Val. Acc: 56.88% |
100%                                    320/320 [00:00<00:00, 425.15it/s]
| Epoch: 145 | Train Loss: 1.342 | Train Acc: 70.16% | Val. Loss: 1.475 | Val. Acc: 56.25% |
100%                                    320/320 [00:00<00:00, 460.23it/s]
| Epoch: 146 | Train Loss: 1.342 | Train Acc: 70.16% | Val. Loss: 1.486 | Val. Acc: 56.25% |
100%                                    320/320 [00:00<00:00, 474.43it/s]
| Epoch: 147 | Train Loss: 1.338 | Train Acc: 70.47% | Val. Loss: 1.513 | Val. Acc: 52.50% |
100%                                    320/320 [00:00<00:00, 605.74it/s]
| Epoch: 148 | Train Loss: 1.343 | Train Acc: 70.00% | Val. Loss: 1.486 | Val. Acc: 55.00% |
100%                                    320/320 [00:00<00:00, 596.46it/s]
| Epoch: 149 | Train Loss: 1.348 | Train Acc: 69.61% | Val. Loss: 1.479 | Val. Acc: 56.88% |
```

| Epoch: 149 | Train Loss: 1.343 | Train Acc: 69.61% | Val. Loss: 1.479 | Val. Acc: 56.88% |
100%   320/320 [00:00<00:00, 579.32it/s]
| Epoch: 150 | Train Loss: 1.340 | Train Acc: 70.39% | Val. Loss: 1.474 | Val. Acc: 56.88% |
100%   320/320 [00:00<00:00, 539.20it/s]
| Epoch: 151 | Train Loss: 1.348 | Train Acc: 69.61% | Val. Loss: 1.468 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 635.73it/s]
| Epoch: 152 | Train Loss: 1.336 | Train Acc: 70.78% | Val. Loss: 1.480 | Val. Acc: 55.62% |
100%   320/320 [00:00<00:00, 502.97it/s]
| Epoch: 153 | Train Loss: 1.332 | Train Acc: 71.09% | Val. Loss: 1.482 | Val. Acc: 56.25% |
100%   320/320 [00:00<00:00, 530.45it/s]
| Epoch: 154 | Train Loss: 1.332 | Train Acc: 71.09% | Val. Loss: 1.463 | Val. Acc: 58.13% |
100%   320/320 [00:00<00:00, 650.54it/s]
| Epoch: 155 | Train Loss: 1.332 | Train Acc: 71.17% | Val. Loss: 1.461 | Val. Acc: 58.75% |
100%   320/320 [00:00<00:00, 490.43it/s]
| Epoch: 156 | Train Loss: 1.323 | Train Acc: 72.03% | Val. Loss: 1.465 | Val. Acc: 58.13% |
100%   320/320 [00:00<00:00, 612.89it/s]
| Epoch: 157 | Train Loss: 1.329 | Train Acc: 71.48% | Val. Loss: 1.468 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 636.80it/s]
| Epoch: 158 | Train Loss: 1.336 | Train Acc: 70.62% | Val. Loss: 1.469 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 469.94it/s]
| Epoch: 159 | Train Loss: 1.334 | Train Acc: 71.09% | Val. Loss: 1.478 | Val. Acc: 56.25% |
100%   320/320 [00:00<00:00, 580.44it/s]
| Epoch: 160 | Train Loss: 1.330 | Train Acc: 71.41% | Val. Loss: 1.474 | Val. Acc: 56.88% |
100%   320/320 [00:00<00:00, 628.79it/s]
| Epoch: 161 | Train Loss: 1.329 | Train Acc: 71.48% | Val. Loss: 1.468 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 502.15it/s]
| Epoch: 162 | Train Loss: 1.350 | Train Acc: 69.38% | Val. Loss: 1.481 | Val. Acc: 56.25% |
100%   320/320 [00:00<00:00, 413.04it/s]
| Epoch: 163 | Train Loss: 1.347 | Train Acc: 69.53% | Val. Loss: 1.493 | Val. Acc: 55.00% |
100%   320/320 [00:00<00:00, 448.64it/s]
| Epoch: 164 | Train Loss: 1.338 | Train Acc: 70.62% | Val. Loss: 1.476 | Val. Acc: 56.88% |
100%   320/320 [00:00<00:00, 477.11it/s]
| Epoch: 165 | Train Loss: 1.343 | Train Acc: 70.16% | Val. Loss: 1.448 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 480.53it/s]
| Epoch: 166 | Train Loss: 1.344 | Train Acc: 69.84% | Val. Loss: 1.464 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 345.18it/s]
| Epoch: 167 | Train Loss: 1.330 | Train Acc: 71.33% | Val. Loss: 1.487 | Val. Acc: 55.00% |
100%   320/320 [00:00<00:00, 374.34it/s]
| Epoch: 168 | Train Loss: 1.328 | Train Acc: 71.56% | Val. Loss: 1.473 | Val. Acc: 56.88% |
100%   320/320 [00:00<00:00, 531.28it/s]
| Epoch: 169 | Train Loss: 1.325 | Train Acc: 71.80% | Val. Loss: 1.466 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 595.95it/s]
| Epoch: 170 | Train Loss: 1.329 | Train Acc: 71.33% | Val. Loss: 1.478 | Val. Acc: 56.25% |
100%   320/320 [00:00<00:00, 571.22it/s]
| Epoch: 171 | Train Loss: 1.325 | Train Acc: 71.88% | Val. Loss: 1.465 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 542.14it/s]
| Epoch: 172 | Train Loss: 1.321 | Train Acc: 72.27% | Val. Loss: 1.464 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 581.16it/s]
| Epoch: 173 | Train Loss: 1.322 | Train Acc: 72.19% | Val. Loss: 1.473 | Val. Acc: 56.88% |
100%   320/320 [00:00<00:00, 566.44it/s]
| Epoch: 174 | Train Loss: 1.320 | Train Acc: 72.34% | Val. Loss: 1.450 | Val. Acc: 59.38% |
100%   320/320 [00:00<00:00, 541.14it/s]
| Epoch: 175 | Train Loss: 1.342 | Train Acc: 70.08% | Val. Loss: 1.442 | Val. Acc: 59.38% |
100%   320/320 [00:00<00:00, 570.29it/s]
| Epoch: 176 | Train Loss: 1.329 | Train Acc: 71.48% | Val. Loss: 1.449 | Val. Acc: 59.38% |
100%   320/320 [00:00<00:00, 572.88it/s]
| Epoch: 177 | Train Loss: 1.336 | Train Acc: 70.70% | Val. Loss: 1.438 | Val. Acc: 60.62% |
100%   320/320 [00:00<00:00, 557.79it/s]
| Epoch: 178 | Train Loss: 1.338 | Train Acc: 70.55% | Val. Loss: 1.461 | Val. Acc: 58.13% |
100%   320/320 [00:00<00:00, 564.91it/s]

```
| Epoch: 179 | Train Loss: 1.334 | Train Acc: 70.94% | Val. Loss: 1.450 | Val. Acc: 59.38% |
100%                              320/320 [00:00<00:00, 557.19it/s]
| Epoch: 180 | Train Loss: 1.336 | Train Acc: 70.70% | Val. Loss: 1.464 | Val. Acc: 58.13% |
100%                              320/320 [00:00<00:00, 577.85it/s]
| Epoch: 181 | Train Loss: 1.338 | Train Acc: 70.55% | Val. Loss: 1.457 | Val. Acc: 58.13% |
100%                              320/320 [00:00<00:00, 494.24it/s]
| Epoch: 182 | Train Loss: 1.344 | Train Acc: 70.08% | Val. Loss: 1.472 | Val. Acc: 56.88% |
100%                              320/320 [00:00<00:00, 556.16it/s]
| Epoch: 183 | Train Loss: 1.333 | Train Acc: 71.09% | Val. Loss: 1.473 | Val. Acc: 56.88% |
100%                              320/320 [00:00<00:00, 433.99it/s]
| Epoch: 184 | Train Loss: 1.334 | Train Acc: 70.86% | Val. Loss: 1.488 | Val. Acc: 55.62% |
100%                              320/320 [00:00<00:00, 451.72it/s]
| Epoch: 185 | Train Loss: 1.330 | Train Acc: 71.33% | Val. Loss: 1.467 | Val. Acc: 57.50% |
100%                              320/320 [00:00<00:00, 445.94it/s]
| Epoch: 186 | Train Loss: 1.330 | Train Acc: 71.33% | Val. Loss: 1.465 | Val. Acc: 57.50% |
100%                              320/320 [00:00<00:00, 459.79it/s]
| Epoch: 187 | Train Loss: 1.332 | Train Acc: 71.17% | Val. Loss: 1.469 | Val. Acc: 57.50% |
100%                              320/320 [00:00<00:00, 324.57it/s]
| Epoch: 188 | Train Loss: 1.332 | Train Acc: 71.17% | Val. Loss: 1.480 | Val. Acc: 56.25% |
100%                              320/320 [00:00<00:00, 387.30it/s]
| Epoch: 189 | Train Loss: 1.342 | Train Acc: 70.16% | Val. Loss: 1.455 | Val. Acc: 58.75% |
100%                              320/320 [00:00<00:00, 522.83it/s]
| Epoch: 190 | Train Loss: 1.358 | Train Acc: 68.52% | Val. Loss: 1.480 | Val. Acc: 56.25% |
100%                              320/320 [00:00<00:00, 534.86it/s]
| Epoch: 191 | Train Loss: 1.344 | Train Acc: 70.00% | Val. Loss: 1.465 | Val. Acc: 57.50% |
100%                              320/320 [00:00<00:00, 599.29it/s]
| Epoch: 192 | Train Loss: 1.330 | Train Acc: 71.41% | Val. Loss: 1.464 | Val. Acc: 58.75% |
100%                              320/320 [00:00<00:00, 562.29it/s]
| Epoch: 193 | Train Loss: 1.339 | Train Acc: 70.55% | Val. Loss: 1.476 | Val. Acc: 56.88% |
100%                              320/320 [00:00<00:00, 587.26it/s]
| Epoch: 194 | Train Loss: 1.345 | Train Acc: 69.77% | Val. Loss: 1.489 | Val. Acc: 55.62% |
100%                              320/320 [00:00<00:00, 549.07it/s]
| Epoch: 195 | Train Loss: 1.351 | Train Acc: 69.14% | Val. Loss: 1.473 | Val. Acc: 56.88% |
100%                              320/320 [00:00<00:00, 553.61it/s]
| Epoch: 196 | Train Loss: 1.335 | Train Acc: 70.86% | Val. Loss: 1.467 | Val. Acc: 57.50% |
100%                              320/320 [00:00<00:00, 574.12it/s]
| Epoch: 197 | Train Loss: 1.330 | Train Acc: 71.33% | Val. Loss: 1.467 | Val. Acc: 57.50% |
100%                              320/320 [00:00<00:00, 491.32it/s]
| Epoch: 198 | Train Loss: 1.330 | Train Acc: 71.33% | Val. Loss: 1.482 | Val. Acc: 55.62% |
100%                              320/320 [00:00<00:00, 526.85it/s]
| Epoch: 199 | Train Loss: 1.326 | Train Acc: 71.80% | Val. Loss: 1.457 | Val. Acc: 58.75% |
100%                              320/320 [00:00<00:00, 601.79it/s]
| Epoch: 200 | Train Loss: 1.353 | Train Acc: 69.14% | Val. Loss: 1.462 | Val. Acc: 57.50% |
| Test Loss: 1.461 | Test Acc: 58.33% |
```

Added one additional fully connected (dense) layer:

- **New layer (`fc3`)**: A fully connected layer with 32 neurons was added between the existing layers and the output.

˅ Summary of Results:

- **Test Loss**: 1.405 — Indicates moderate model performance, with room for improvement in minimizing errors.
- **Test Accuracy**: 64.17% — The model correctly predicts the labels for 64.17% of the test samples.
- **Precision**: 0.61 — Of all positive predictions, 61% were correct. Some false positives are present.
- **Recall**: 0.64 — The model captures 64% of the actual positive instances, missing 36% of them (false negatives).
- **F1-Score**: 0.62 — Reflects a balance between precision and recall, showing moderate overall performance but with potential for improvement.

Start coding or generate with AI.

```python
class WineModel(nn.Module):
    def __init__(self):
        super(WineModel, self).__init__()
        # Existing layers
        self.fc1 = nn.Linear(input_size, 128)
        self.fc2 = nn.Linear(128, 64)

        # New layer added here
        self.fc3 = nn.Linear(64, 32)  # New layer with 32 neurons

        # Output layer
        self.fc4 = nn.Linear(32, num_classes)

    def forward(self, x):
        x = F.relu(self.fc1(x))
        x = F.relu(self.fc2(x))
        x = F.relu(self.fc3(x))  # New layer in the forward pass
        x = self.fc4(x)
        return x
```

```python
# Re-initialize the optimizer since the model has changed
optimizer = Adam(winemodel.parameters(), lr=5e-3)  # You can adjust the learning rate as needed

# Increase the number of epochs to 200 or as needed
num_epochs = 200

# Training loop
for epoch in range(num_epochs):
    train_loss, train_acc = train(winemodel, train_dataloader, optimizer, criterion)
    valid_loss, valid_acc = evaluate(winemodel, val_dataloader, criterion)

    print(f'| Epoch: {epoch+1:02} | Train Loss: {train_loss:.3f} | Train Acc: {train_acc*100:.2f}% | Val. Loss: {valid_loss:.3f} | Val. Acc:

# Evaluate on the test set after training
test_loss, test_acc = test_evaluate(winemodel, test_dataloader, criterion)

print(f'| Test Loss: {test_loss:.3f} | Test Acc: {test_acc*100:.2f}% |')
```

100%   320/320 [00:00<00:00, 691.48it/s]

| Epoch: 01 | Train Loss: 1.372 | Train Acc: 67.03% | Val. Loss: 1.452 | Val. Acc: 58.75% |
100%   320/320 [00:00<00:00, 569.81it/s]

| Epoch: 02 | Train Loss: 1.347 | Train Acc: 69.61% | Val. Loss: 1.465 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 580.45it/s]

| Epoch: 03 | Train Loss: 1.334 | Train Acc: 70.94% | Val. Loss: 1.464 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 631.42it/s]

| Epoch: 04 | Train Loss: 1.328 | Train Acc: 71.48% | Val. Loss: 1.467 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 685.07it/s]

| Epoch: 05 | Train Loss: 1.328 | Train Acc: 71.56% | Val. Loss: 1.458 | Val. Acc: 58.75% |
100%   320/320 [00:00<00:00, 409.63it/s]

| Epoch: 06 | Train Loss: 1.322 | Train Acc: 72.19% | Val. Loss: 1.444 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 474.56it/s]

| Epoch: 07 | Train Loss: 1.333 | Train Acc: 71.02% | Val. Loss: 1.465 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 371.75it/s]

| Epoch: 08 | Train Loss: 1.325 | Train Acc: 71.80% | Val. Loss: 1.470 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 421.46it/s]

| Epoch: 09 | Train Loss: 1.322 | Train Acc: 72.11% | Val. Loss: 1.442 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 665.34it/s]

| Epoch: 10 | Train Loss: 1.326 | Train Acc: 71.80% | Val. Loss: 1.437 | Val. Acc: 60.62% |
100%   320/320 [00:00<00:00, 510.25it/s]

| Epoch: 11 | Train Loss: 1.320 | Train Acc: 72.34% | Val. Loss: 1.438 | Val. Acc: 60.62% |
100%   320/320 [00:00<00:00, 628.45it/s]

| Epoch: 12 | Train Loss: 1.320 | Train Acc: 72.34% | Val. Loss: 1.438 | Val. Acc: 60.62% |
100%   320/320 [00:00<00:00, 676.44it/s]

| Epoch: 13 | Train Loss: 1.327 | Train Acc: 71.64% | Val. Loss: 1.455 | Val. Acc: 58.75% |
100%   320/320 [00:00<00:00, 529.89it/s]

| Epoch: 14 | Train Loss: 1.328 | Train Acc: 71.56% | Val. Loss: 1.451 | Val. Acc: 59.38% |
100%   320/320 [00:00<00:00, 591.74it/s]

| Epoch: 15 | Train Loss: 1.324 | Train Acc: 71.95% | Val. Loss: 1.446 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 645.79it/s]

| Epoch: 16 | Train Loss: 1.333 | Train Acc: 71.02% | Val. Loss: 1.461 | Val. Acc: 58.13% |
100%   320/320 [00:00<00:00, 648.55it/s]

| Epoch: 17 | Train Loss: 1.334 | Train Acc: 70.94% | Val. Loss: 1.454 | Val. Acc: 58.75% |
100%   320/320 [00:00<00:00, 509.97it/s]

| Epoch: 18 | Train Loss: 1.323 | Train Acc: 72.11% | Val. Loss: 1.438 | Val. Acc: 60.62% |
100%   320/320 [00:00<00:00, 613.33it/s]

| Epoch: 19 | Train Loss: 1.330 | Train Acc: 71.33% | Val. Loss: 1.471 | Val. Acc: 56.88% |
100%   320/320 [00:00<00:00, 671.50it/s]

| Epoch: 20 | Train Loss: 1.333 | Train Acc: 71.09% | Val. Loss: 1.461 | Val. Acc: 58.13% |
100%   320/320 [00:00<00:00, 502.96it/s]

| Epoch: 21 | Train Loss: 1.330 | Train Acc: 71.41% | Val. Loss: 1.463 | Val. Acc: 58.13% |
100%   320/320 [00:00<00:00, 554.23it/s]

| Epoch: 22 | Train Loss: 1.328 | Train Acc: 71.56% | Val. Loss: 1.463 | Val. Acc: 58.13% |
100%   320/320 [00:00<00:00, 618.38it/s]

| Epoch: 23 | Train Loss: 1.328 | Train Acc: 71.56% | Val. Loss: 1.469 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 561.71it/s]

| Epoch: 24 | Train Loss: 1.324 | Train Acc: 72.03% | Val. Loss: 1.470 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 640.94it/s]

| Epoch: 25 | Train Loss: 1.323 | Train Acc: 71.95% | Val. Loss: 1.476 | Val. Acc: 56.88% |
100%   320/320 [00:00<00:00, 527.10it/s]

| Epoch: 26 | Train Loss: 1.332 | Train Acc: 71.09% | Val. Loss: 1.483 | Val. Acc: 56.25% |
100%   320/320 [00:00<00:00, 490.28it/s]

| Epoch: 27 | Train Loss: 1.330 | Train Acc: 71.48% | Val. Loss: 1.504 | Val. Acc: 53.75% |
100%   320/320 [00:00<00:00, 510.20it/s]

| Epoch: 28 | Train Loss: 1.341 | Train Acc: 70.31% | Val. Loss: 1.474 | Val. Acc: 56.88% |
100%   320/320 [00:00<00:00, 412.45it/s]

| Epoch: 29 | Train Loss: 1.339 | Train Acc: 70.39% | Val. Loss: 1.471 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 442.86it/s]

```
| Epoch: 30 | Train Loss: 1.338 | Train Acc: 70.62% | Val. Loss: 1.470 | Val. Acc: 57.50% |
100%                            320/320 [00:00<00:00, 388.91it/s]
| Epoch: 31 | Train Loss: 1.331 | Train Acc: 71.25% | Val. Loss: 1.473 | Val. Acc: 56.88% |
100%                            320/320 [00:00<00:00, 603.34it/s]
| Epoch: 32 | Train Loss: 1.327 | Train Acc: 71.64% | Val. Loss: 1.470 | Val. Acc: 57.50% |
100%                            320/320 [00:00<00:00, 651.81it/s]
| Epoch: 33 | Train Loss: 1.326 | Train Acc: 71.80% | Val. Loss: 1.471 | Val. Acc: 57.50% |
100%                            320/320 [00:00<00:00, 555.45it/s]
| Epoch: 34 | Train Loss: 1.328 | Train Acc: 71.56% | Val. Loss: 1.480 | Val. Acc: 56.25% |
100%                            320/320 [00:00<00:00, 530.99it/s]
| Epoch: 35 | Train Loss: 1.348 | Train Acc: 69.53% | Val. Loss: 1.463 | Val. Acc: 58.13% |
100%                            320/320 [00:00<00:00, 653.19it/s]
| Epoch: 36 | Train Loss: 1.333 | Train Acc: 71.02% | Val. Loss: 1.467 | Val. Acc: 57.50% |
100%                            320/320 [00:00<00:00, 672.36it/s]
| Epoch: 37 | Train Loss: 1.333 | Train Acc: 70.94% | Val. Loss: 1.469 | Val. Acc: 57.50% |
100%                            320/320 [00:00<00:00, 528.89it/s]
| Epoch: 38 | Train Loss: 1.330 | Train Acc: 71.48% | Val. Loss: 1.464 | Val. Acc: 58.13% |
100%                            320/320 [00:00<00:00, 571.11it/s]
| Epoch: 39 | Train Loss: 1.335 | Train Acc: 70.86% | Val. Loss: 1.475 | Val. Acc: 57.50% |
100%                            320/320 [00:00<00:00, 676.87it/s]
| Epoch: 40 | Train Loss: 1.334 | Train Acc: 70.94% | Val. Loss: 1.476 | Val. Acc: 56.88% |
100%                            320/320 [00:00<00:00, 516.43it/s]
| Epoch: 41 | Train Loss: 1.336 | Train Acc: 70.94% | Val. Loss: 1.469 | Val. Acc: 57.50% |
100%                            320/320 [00:00<00:00, 628.27it/s]
| Epoch: 42 | Train Loss: 1.335 | Train Acc: 70.86% | Val. Loss: 1.462 | Val. Acc: 58.13% |
100%                            320/320 [00:00<00:00, 657.18it/s]
| Epoch: 43 | Train Loss: 1.324 | Train Acc: 71.95% | Val. Loss: 1.457 | Val. Acc: 58.75% |
100%                            320/320 [00:00<00:00, 599.73it/s]
| Epoch: 44 | Train Loss: 1.335 | Train Acc: 70.78% | Val. Loss: 1.482 | Val. Acc: 55.62% |
100%                            320/320 [00:00<00:00, 489.13it/s]
| Epoch: 45 | Train Loss: 1.332 | Train Acc: 71.17% | Val. Loss: 1.469 | Val. Acc: 57.50% |
100%                            320/320 [00:00<00:00, 622.22it/s]
| Epoch: 46 | Train Loss: 1.345 | Train Acc: 69.77% | Val. Loss: 1.472 | Val. Acc: 56.88% |
100%                            320/320 [00:00<00:00, 670.10it/s]
| Epoch: 47 | Train Loss: 1.329 | Train Acc: 71.56% | Val. Loss: 1.475 | Val. Acc: 56.88% |
100%                            320/320 [00:00<00:00, 425.86it/s]
| Epoch: 48 | Train Loss: 1.322 | Train Acc: 72.11% | Val. Loss: 1.469 | Val. Acc: 57.50% |
100%                            320/320 [00:00<00:00, 463.51it/s]
| Epoch: 49 | Train Loss: 1.326 | Train Acc: 71.80% | Val. Loss: 1.465 | Val. Acc: 57.50% |
100%                            320/320 [00:00<00:00, 439.10it/s]
| Epoch: 50 | Train Loss: 1.324 | Train Acc: 71.95% | Val. Loss: 1.462 | Val. Acc: 57.50% |
100%                            320/320 [00:00<00:00, 399.76it/s]
| Epoch: 51 | Train Loss: 1.323 | Train Acc: 72.11% | Val. Loss: 1.467 | Val. Acc: 56.88% |
100%                            320/320 [00:00<00:00, 355.66it/s]
| Epoch: 52 | Train Loss: 1.334 | Train Acc: 70.86% | Val. Loss: 1.449 | Val. Acc: 59.38% |
100%                            320/320 [00:00<00:00, 639.36it/s]
| Epoch: 53 | Train Loss: 1.337 | Train Acc: 70.70% | Val. Loss: 1.472 | Val. Acc: 57.50% |
100%                            320/320 [00:00<00:00, 559.56it/s]
| Epoch: 54 | Train Loss: 1.328 | Train Acc: 71.56% | Val. Loss: 1.454 | Val. Acc: 58.75% |
100%                            320/320 [00:00<00:00, 583.44it/s]
| Epoch: 55 | Train Loss: 1.322 | Train Acc: 72.19% | Val. Loss: 1.445 | Val. Acc: 60.00% |
100%                            320/320 [00:00<00:00, 681.91it/s]
| Epoch: 56 | Train Loss: 1.330 | Train Acc: 71.33% | Val. Loss: 1.473 | Val. Acc: 56.88% |
100%                            320/320 [00:00<00:00, 607.46it/s]
| Epoch: 57 | Train Loss: 1.324 | Train Acc: 71.95% | Val. Loss: 1.464 | Val. Acc: 57.50% |
100%                            320/320 [00:00<00:00, 512.47it/s]
| Epoch: 58 | Train Loss: 1.328 | Train Acc: 71.56% | Val. Loss: 1.451 | Val. Acc: 59.38% |
100%                            320/320 [00:00<00:00, 632.55it/s]
| Epoch: 59 | Train Loss: 1.325 | Train Acc: 71.80% | Val. Loss: 1.444 | Val. Acc: 60.00% |
100%                            320/320 [00:00<00:00, 663.91it/s]
```

| Epoch: 60 | Train Loss: 1.322 | Train Acc: 72.11% | Val. Loss: 1.445 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 530.29it/s]
| Epoch: 61 | Train Loss: 1.319 | Train Acc: 72.50% | Val. Loss: 1.457 | Val. Acc: 58.13% |
100%   320/320 [00:00<00:00, 580.22it/s]
| Epoch: 62 | Train Loss: 1.322 | Train Acc: 72.19% | Val. Loss: 1.466 | Val. Acc: 58.13% |
100%   320/320 [00:00<00:00, 671.14it/s]
| Epoch: 63 | Train Loss: 1.328 | Train Acc: 71.56% | Val. Loss: 1.489 | Val. Acc: 55.00% |
100%   320/320 [00:00<00:00, 526.23it/s]
| Epoch: 64 | Train Loss: 1.320 | Train Acc: 72.34% | Val. Loss: 1.474 | Val. Acc: 56.88% |
100%   320/320 [00:00<00:00, 578.60it/s]
| Epoch: 65 | Train Loss: 1.325 | Train Acc: 71.88% | Val. Loss: 1.474 | Val. Acc: 56.88% |
100%   320/320 [00:00<00:00, 649.85it/s]
| Epoch: 66 | Train Loss: 1.327 | Train Acc: 71.72% | Val. Loss: 1.453 | Val. Acc: 58.75% |
100%   320/320 [00:00<00:00, 568.33it/s]
| Epoch: 67 | Train Loss: 1.328 | Train Acc: 71.56% | Val. Loss: 1.462 | Val. Acc: 58.13% |
100%   320/320 [00:00<00:00, 482.79it/s]
| Epoch: 68 | Train Loss: 1.323 | Train Acc: 72.03% | Val. Loss: 1.453 | Val. Acc: 58.75% |
100%   320/320 [00:00<00:00, 486.00it/s]
| Epoch: 69 | Train Loss: 1.327 | Train Acc: 71.72% | Val. Loss: 1.462 | Val. Acc: 58.13% |
100%   320/320 [00:01<00:00, 285.87it/s]
| Epoch: 70 | Train Loss: 1.323 | Train Acc: 72.11% | Val. Loss: 1.456 | Val. Acc: 58.75% |
100%   320/320 [00:00<00:00, 320.31it/s]
| Epoch: 71 | Train Loss: 1.322 | Train Acc: 72.11% | Val. Loss: 1.431 | Val. Acc: 61.25% |
100%   320/320 [00:00<00:00, 569.17it/s]
| Epoch: 72 | Train Loss: 1.327 | Train Acc: 71.64% | Val. Loss: 1.448 | Val. Acc: 59.38% |
100%   320/320 [00:00<00:00, 656.18it/s]
| Epoch: 73 | Train Loss: 1.335 | Train Acc: 70.86% | Val. Loss: 1.457 | Val. Acc: 58.75% |
100%   320/320 [00:00<00:00, 499.85it/s]
| Epoch: 74 | Train Loss: 1.324 | Train Acc: 71.95% | Val. Loss: 1.444 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 587.85it/s]
| Epoch: 75 | Train Loss: 1.320 | Train Acc: 72.34% | Val. Loss: 1.448 | Val. Acc: 59.38% |
100%   320/320 [00:00<00:00, 643.24it/s]
| Epoch: 76 | Train Loss: 1.318 | Train Acc: 72.58% | Val. Loss: 1.446 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 558.27it/s]
| Epoch: 77 | Train Loss: 1.319 | Train Acc: 72.42% | Val. Loss: 1.457 | Val. Acc: 58.75% |
100%   320/320 [00:00<00:00, 499.14it/s]
| Epoch: 78 | Train Loss: 1.337 | Train Acc: 70.70% | Val. Loss: 1.446 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 634.73it/s]
| Epoch: 79 | Train Loss: 1.321 | Train Acc: 72.27% | Val. Loss: 1.445 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 581.87it/s]
| Epoch: 80 | Train Loss: 1.338 | Train Acc: 70.62% | Val. Loss: 1.455 | Val. Acc: 58.75% |
100%   320/320 [00:00<00:00, 504.58it/s]
| Epoch: 81 | Train Loss: 1.342 | Train Acc: 70.23% | Val. Loss: 1.449 | Val. Acc: 59.38% |
100%   320/320 [00:00<00:00, 607.47it/s]
| Epoch: 82 | Train Loss: 1.345 | Train Acc: 69.92% | Val. Loss: 1.437 | Val. Acc: 60.62% |
100%   320/320 [00:00<00:00, 593.79it/s]
| Epoch: 83 | Train Loss: 1.333 | Train Acc: 71.02% | Val. Loss: 1.449 | Val. Acc: 59.38% |
100%   320/320 [00:00<00:00, 565.47it/s]
| Epoch: 84 | Train Loss: 1.324 | Train Acc: 71.88% | Val. Loss: 1.457 | Val. Acc: 58.75% |
100%   320/320 [00:00<00:00, 524.46it/s]
| Epoch: 85 | Train Loss: 1.329 | Train Acc: 71.48% | Val. Loss: 1.467 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 633.63it/s]
| Epoch: 86 | Train Loss: 1.337 | Train Acc: 70.62% | Val. Loss: 1.455 | Val. Acc: 58.75% |
100%   320/320 [00:00<00:00, 487.99it/s]
| Epoch: 87 | Train Loss: 1.344 | Train Acc: 70.08% | Val. Loss: 1.448 | Val. Acc: 59.38% |
100%   320/320 [00:00<00:00, 412.44it/s]
| Epoch: 88 | Train Loss: 1.364 | Train Acc: 67.89% | Val. Loss: 1.441 | Val. Acc: 59.38% |
100%   320/320 [00:00<00:00, 426.50it/s]
| Epoch: 89 | Train Loss: 1.351 | Train Acc: 69.45% | Val. Loss: 1.465 | Val. Acc: 58.13% |

```
100%                             320/320 [00:00<00:00, 440.20it/s]
| Epoch: 90 | Train Loss: 1.333 | Train Acc: 70.94% | Val. Loss: 1.446 | Val. Acc: 59.38% |
100%                             320/320 [00:00<00:00, 430.17it/s]
| Epoch: 91 | Train Loss: 1.328 | Train Acc: 71.64% | Val. Loss: 1.439 | Val. Acc: 60.00% |
100%                             320/320 [00:00<00:00, 344.50it/s]
| Epoch: 92 | Train Loss: 1.320 | Train Acc: 72.34% | Val. Loss: 1.443 | Val. Acc: 60.00% |
100%                             320/320 [00:00<00:00, 602.84it/s]
| Epoch: 93 | Train Loss: 1.331 | Train Acc: 71.02% | Val. Loss: 1.440 | Val. Acc: 60.00% |
100%                             320/320 [00:00<00:00, 581.49it/s]
| Epoch: 94 | Train Loss: 1.335 | Train Acc: 70.78% | Val. Loss: 1.449 | Val. Acc: 59.38% |
100%                             320/320 [00:00<00:00, 553.80it/s]
| Epoch: 95 | Train Loss: 1.328 | Train Acc: 71.48% | Val. Loss: 1.450 | Val. Acc: 59.38% |
100%                             320/320 [00:00<00:00, 560.05it/s]
| Epoch: 96 | Train Loss: 1.323 | Train Acc: 72.03% | Val. Loss: 1.462 | Val. Acc: 58.13% |
100%                             320/320 [00:00<00:00, 610.91it/s]
| Epoch: 97 | Train Loss: 1.320 | Train Acc: 72.34% | Val. Loss: 1.459 | Val. Acc: 58.75% |
100%                             320/320 [00:00<00:00, 537.52it/s]
| Epoch: 98 | Train Loss: 1.317 | Train Acc: 72.58% | Val. Loss: 1.463 | Val. Acc: 58.13% |
100%                             320/320 [00:00<00:00, 552.22it/s]
| Epoch: 99 | Train Loss: 1.323 | Train Acc: 71.95% | Val. Loss: 1.456 | Val. Acc: 59.38% |
100%                             320/320 [00:00<00:00, 640.50it/s]
| Epoch: 100 | Train Loss: 1.339 | Train Acc: 70.39% | Val. Loss: 1.441 | Val. Acc: 60.00% |
100%                             320/320 [00:00<00:00, 483.10it/s]
| Epoch: 101 | Train Loss: 1.324 | Train Acc: 72.03% | Val. Loss: 1.442 | Val. Acc: 60.00% |
100%                             320/320 [00:00<00:00, 560.98it/s]
| Epoch: 102 | Train Loss: 1.316 | Train Acc: 72.81% | Val. Loss: 1.444 | Val. Acc: 60.00% |
100%                             320/320 [00:00<00:00, 648.69it/s]
| Epoch: 103 | Train Loss: 1.335 | Train Acc: 70.86% | Val. Loss: 1.435 | Val. Acc: 60.62% |
100%                             320/320 [00:00<00:00, 485.59it/s]
| Epoch: 104 | Train Loss: 1.328 | Train Acc: 71.41% | Val. Loss: 1.451 | Val. Acc: 59.38% |
100%                             320/320 [00:00<00:00, 542.21it/s]
| Epoch: 105 | Train Loss: 1.329 | Train Acc: 71.48% | Val. Loss: 1.459 | Val. Acc: 58.13% |
100%                             320/320 [00:00<00:00, 647.27it/s]
| Epoch: 106 | Train Loss: 1.326 | Train Acc: 71.80% | Val. Loss: 1.462 | Val. Acc: 58.13% |
100%                             320/320 [00:00<00:00, 481.23it/s]
| Epoch: 107 | Train Loss: 1.319 | Train Acc: 72.42% | Val. Loss: 1.466 | Val. Acc: 57.50% |
100%                             320/320 [00:00<00:00, 561.57it/s]
| Epoch: 108 | Train Loss: 1.317 | Train Acc: 72.73% | Val. Loss: 1.452 | Val. Acc: 58.75% |
100%                             320/320 [00:00<00:00, 492.94it/s]
| Epoch: 109 | Train Loss: 1.321 | Train Acc: 72.27% | Val. Loss: 1.460 | Val. Acc: 58.13% |
100%                             320/320 [00:00<00:00, 445.90it/s]
| Epoch: 110 | Train Loss: 1.326 | Train Acc: 71.72% | Val. Loss: 1.461 | Val. Acc: 58.13% |
100%                             320/320 [00:00<00:00, 400.59it/s]
| Epoch: 111 | Train Loss: 1.325 | Train Acc: 71.88% | Val. Loss: 1.462 | Val. Acc: 58.13% |
100%                             320/320 [00:00<00:00, 359.40it/s]
| Epoch: 112 | Train Loss: 1.332 | Train Acc: 71.02% | Val. Loss: 1.463 | Val. Acc: 58.13% |
100%                             320/320 [00:00<00:00, 411.78it/s]
| Epoch: 113 | Train Loss: 1.323 | Train Acc: 72.11% | Val. Loss: 1.457 | Val. Acc: 58.75% |
100%                             320/320 [00:00<00:00, 595.73it/s]
| Epoch: 114 | Train Loss: 1.322 | Train Acc: 72.11% | Val. Loss: 1.456 | Val. Acc: 58.75% |
100%                             320/320 [00:00<00:00, 537.11it/s]
| Epoch: 115 | Train Loss: 1.318 | Train Acc: 72.58% | Val. Loss: 1.457 | Val. Acc: 58.75% |
100%                             320/320 [00:00<00:00, 531.63it/s]
| Epoch: 116 | Train Loss: 1.325 | Train Acc: 71.80% | Val. Loss: 1.471 | Val. Acc: 57.50% |
100%                             320/320 [00:00<00:00, 615.14it/s]
| Epoch: 117 | Train Loss: 1.323 | Train Acc: 72.03% | Val. Loss: 1.454 | Val. Acc: 59.38% |
100%                             320/320 [00:00<00:00, 491.68it/s]
| Epoch: 118 | Train Loss: 1.323 | Train Acc: 72.03% | Val. Loss: 1.449 | Val. Acc: 59.38% |
100%                             320/320 [00:00<00:00, 540.27it/s]
| Epoch: 119 | Train Loss: 1.338 | Train Acc: 70.55% | Val. Loss: 1.476 | Val. Acc: 56.88% |
```

```
100%                                    320/320 [00:00<00:00, 663.42it/s]
| Epoch: 120 | Train Loss: 1.349 | Train Acc: 69.45% | Val. Loss: 1.463 | Val. Acc: 58.13% |
100%                                    320/320 [00:00<00:00, 514.09it/s]
| Epoch: 121 | Train Loss: 1.333 | Train Acc: 71.09% | Val. Loss: 1.454 | Val. Acc: 58.75% |
100%                                    320/320 [00:00<00:00, 543.15it/s]
| Epoch: 122 | Train Loss: 1.330 | Train Acc: 71.33% | Val. Loss: 1.467 | Val. Acc: 57.50% |
100%                                    320/320 [00:00<00:00, 614.26it/s]
| Epoch: 123 | Train Loss: 1.332 | Train Acc: 71.09% | Val. Loss: 1.459 | Val. Acc: 58.13% |
100%                                    320/320 [00:00<00:00, 556.17it/s]
| Epoch: 124 | Train Loss: 1.336 | Train Acc: 70.62% | Val. Loss: 1.458 | Val. Acc: 58.75% |
100%                                    320/320 [00:00<00:00, 601.08it/s]
| Epoch: 125 | Train Loss: 1.325 | Train Acc: 71.88% | Val. Loss: 1.455 | Val. Acc: 58.75% |
100%                                    320/320 [00:00<00:00, 580.81it/s]
| Epoch: 126 | Train Loss: 1.325 | Train Acc: 71.88% | Val. Loss: 1.462 | Val. Acc: 58.13% |
100%                                    320/320 [00:00<00:00, 521.58it/s]
| Epoch: 127 | Train Loss: 1.321 | Train Acc: 72.34% | Val. Loss: 1.456 | Val. Acc: 58.75% |
100%                                    320/320 [00:00<00:00, 658.78it/s]
| Epoch: 128 | Train Loss: 1.331 | Train Acc: 71.25% | Val. Loss: 1.457 | Val. Acc: 58.75% |
100%                                    320/320 [00:00<00:00, 406.82it/s]
| Epoch: 129 | Train Loss: 1.315 | Train Acc: 72.89% | Val. Loss: 1.455 | Val. Acc: 58.75% |
100%                                    320/320 [00:00<00:00, 463.36it/s]
| Epoch: 130 | Train Loss: 1.312 | Train Acc: 73.20% | Val. Loss: 1.456 | Val. Acc: 58.13% |
100%                                    320/320 [00:00<00:00, 408.82it/s]
| Epoch: 131 | Train Loss: 1.312 | Train Acc: 73.20% | Val. Loss: 1.455 | Val. Acc: 59.38% |
100%                                    320/320 [00:00<00:00, 398.54it/s]
| Epoch: 132 | Train Loss: 1.317 | Train Acc: 72.58% | Val. Loss: 1.449 | Val. Acc: 59.38% |
100%                                    320/320 [00:00<00:00, 435.55it/s]
| Epoch: 133 | Train Loss: 1.316 | Train Acc: 72.73% | Val. Loss: 1.450 | Val. Acc: 59.38% |
100%                                    320/320 [00:00<00:00, 425.93it/s]
| Epoch: 134 | Train Loss: 1.310 | Train Acc: 73.36% | Val. Loss: 1.454 | Val. Acc: 58.75% |
100%                                    320/320 [00:00<00:00, 533.74it/s]
| Epoch: 135 | Train Loss: 1.323 | Train Acc: 72.11% | Val. Loss: 1.463 | Val. Acc: 58.13% |
100%                                    320/320 [00:00<00:00, 557.81it/s]
| Epoch: 136 | Train Loss: 1.320 | Train Acc: 72.34% | Val. Loss: 1.450 | Val. Acc: 59.38% |
100%                                    320/320 [00:00<00:00, 592.17it/s]
| Epoch: 137 | Train Loss: 1.321 | Train Acc: 72.11% | Val. Loss: 1.460 | Val. Acc: 58.13% |
100%                                    320/320 [00:00<00:00, 564.77it/s]
| Epoch: 138 | Train Loss: 1.333 | Train Acc: 71.09% | Val. Loss: 1.445 | Val. Acc: 60.00% |
100%                                    320/320 [00:00<00:00, 595.18it/s]
| Epoch: 139 | Train Loss: 1.332 | Train Acc: 71.09% | Val. Loss: 1.466 | Val. Acc: 57.50% |
100%                                    320/320 [00:00<00:00, 508.90it/s]
| Epoch: 140 | Train Loss: 1.322 | Train Acc: 72.11% | Val. Loss: 1.457 | Val. Acc: 58.75% |
100%                                    320/320 [00:00<00:00, 566.57it/s]
| Epoch: 141 | Train Loss: 1.321 | Train Acc: 72.27% | Val. Loss: 1.467 | Val. Acc: 57.50% |
100%                                    320/320 [00:00<00:00, 602.43it/s]
| Epoch: 142 | Train Loss: 1.322 | Train Acc: 72.19% | Val. Loss: 1.465 | Val. Acc: 58.13% |
100%                                    320/320 [00:00<00:00, 505.28it/s]
| Epoch: 143 | Train Loss: 1.321 | Train Acc: 72.19% | Val. Loss: 1.456 | Val. Acc: 58.75% |
100%                                    320/320 [00:00<00:00, 543.86it/s]
| Epoch: 144 | Train Loss: 1.315 | Train Acc: 72.89% | Val. Loss: 1.456 | Val. Acc: 58.75% |
100%                                    320/320 [00:00<00:00, 634.22it/s]
| Epoch: 145 | Train Loss: 1.313 | Train Acc: 73.05% | Val. Loss: 1.457 | Val. Acc: 58.75% |
100%                                    320/320 [00:00<00:00, 522.46it/s]
| Epoch: 146 | Train Loss: 1.313 | Train Acc: 73.05% | Val. Loss: 1.457 | Val. Acc: 58.75% |
100%                                    320/320 [00:00<00:00, 535.03it/s]
| Epoch: 147 | Train Loss: 1.319 | Train Acc: 72.42% | Val. Loss: 1.463 | Val. Acc: 57.50% |
100%                                    320/320 [00:00<00:00, 595.26it/s]
| Epoch: 148 | Train Loss: 1.317 | Train Acc: 72.66% | Val. Loss: 1.478 | Val. Acc: 56.88% |
100%                                    320/320 [00:00<00:00, 587.74it/s]
| Epoch: 149 | Train Loss: 1.327 | Train Acc: 71.72% | Val. Loss: 1.460 | Val. Acc: 58.13% |
```

| Epoch: 149 | Train Loss: 1.327 | Train Acc: 71.72% | Val. Loss: 1.460 | Val. Acc: 58.13% |
100%   320/320 [00:00<00:00, 423.68it/s]
| Epoch: 150 | Train Loss: 1.316 | Train Acc: 72.73% | Val. Loss: 1.460 | Val. Acc: 58.13% |
100%   320/320 [00:00<00:00, 400.45it/s]
| Epoch: 151 | Train Loss: 1.314 | Train Acc: 72.97% | Val. Loss: 1.479 | Val. Acc: 56.25% |
100%   320/320 [00:00<00:00, 475.01it/s]
| Epoch: 152 | Train Loss: 1.315 | Train Acc: 72.89% | Val. Loss: 1.456 | Val. Acc: 58.75% |
100%   320/320 [00:00<00:00, 411.66it/s]
| Epoch: 153 | Train Loss: 1.318 | Train Acc: 72.58% | Val. Loss: 1.456 | Val. Acc: 58.75% |
100%   320/320 [00:00<00:00, 408.80it/s]
| Epoch: 154 | Train Loss: 1.319 | Train Acc: 72.42% | Val. Loss: 1.444 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 405.54it/s]
| Epoch: 155 | Train Loss: 1.318 | Train Acc: 72.58% | Val. Loss: 1.450 | Val. Acc: 59.38% |
100%   320/320 [00:00<00:00, 565.75it/s]
| Epoch: 156 | Train Loss: 1.312 | Train Acc: 73.12% | Val. Loss: 1.445 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 593.63it/s]
| Epoch: 157 | Train Loss: 1.323 | Train Acc: 72.19% | Val. Loss: 1.445 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 554.09it/s]
| Epoch: 158 | Train Loss: 1.324 | Train Acc: 71.80% | Val. Loss: 1.472 | Val. Acc: 56.88% |
100%   320/320 [00:00<00:00, 549.45it/s]
| Epoch: 159 | Train Loss: 1.327 | Train Acc: 71.64% | Val. Loss: 1.470 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 513.90it/s]
| Epoch: 160 | Train Loss: 1.328 | Train Acc: 71.56% | Val. Loss: 1.449 | Val. Acc: 59.38% |
100%   320/320 [00:00<00:00, 576.93it/s]
| Epoch: 161 | Train Loss: 1.328 | Train Acc: 71.41% | Val. Loss: 1.462 | Val. Acc: 58.13% |
100%   320/320 [00:00<00:00, 558.00it/s]
| Epoch: 162 | Train Loss: 1.317 | Train Acc: 72.73% | Val. Loss: 1.461 | Val. Acc: 58.13% |
100%   320/320 [00:00<00:00, 563.26it/s]
| Epoch: 163 | Train Loss: 1.316 | Train Acc: 72.73% | Val. Loss: 1.462 | Val. Acc: 58.13% |
100%   320/320 [00:00<00:00, 584.89it/s]
| Epoch: 164 | Train Loss: 1.318 | Train Acc: 72.50% | Val. Loss: 1.451 | Val. Acc: 59.38% |
100%   320/320 [00:00<00:00, 592.11it/s]
| Epoch: 165 | Train Loss: 1.316 | Train Acc: 72.73% | Val. Loss: 1.446 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 534.65it/s]
| Epoch: 166 | Train Loss: 1.317 | Train Acc: 72.58% | Val. Loss: 1.440 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 560.45it/s]
| Epoch: 167 | Train Loss: 1.328 | Train Acc: 71.56% | Val. Loss: 1.459 | Val. Acc: 58.13% |
100%   320/320 [00:00<00:00, 605.67it/s]
| Epoch: 168 | Train Loss: 1.323 | Train Acc: 72.11% | Val. Loss: 1.445 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 487.93it/s]
| Epoch: 169 | Train Loss: 1.325 | Train Acc: 71.80% | Val. Loss: 1.456 | Val. Acc: 58.75% |
100%   320/320 [00:00<00:00, 580.23it/s]
| Epoch: 170 | Train Loss: 1.330 | Train Acc: 71.25% | Val. Loss: 1.463 | Val. Acc: 58.13% |
100%   320/320 [00:00<00:00, 428.77it/s]
| Epoch: 171 | Train Loss: 1.330 | Train Acc: 71.33% | Val. Loss: 1.461 | Val. Acc: 58.13% |
100%   320/320 [00:00<00:00, 386.13it/s]
| Epoch: 172 | Train Loss: 1.332 | Train Acc: 71.09% | Val. Loss: 1.463 | Val. Acc: 58.13% |
100%   320/320 [00:00<00:00, 373.27it/s]
| Epoch: 173 | Train Loss: 1.322 | Train Acc: 72.19% | Val. Loss: 1.462 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 387.59it/s]
| Epoch: 174 | Train Loss: 1.327 | Train Acc: 71.64% | Val. Loss: 1.443 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 441.88it/s]
| Epoch: 175 | Train Loss: 1.318 | Train Acc: 72.58% | Val. Loss: 1.442 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 448.90it/s]
| Epoch: 176 | Train Loss: 1.314 | Train Acc: 72.97% | Val. Loss: 1.450 | Val. Acc: 59.38% |
100%   320/320 [00:00<00:00, 524.27it/s]
| Epoch: 177 | Train Loss: 1.314 | Train Acc: 72.97% | Val. Loss: 1.448 | Val. Acc: 59.38% |
100%   320/320 [00:00<00:00, 627.78it/s]
| Epoch: 178 | Train Loss: 1.313 | Train Acc: 73.05% | Val. Loss: 1.448 | Val. Acc: 59.38% |
100%   320/320 [00:00<00:00, 487.08it/s]

```
| Epoch: 179 | Train Loss: 1.313 | Train Acc: 73.05% | Val. Loss: 1.453 | Val. Acc: 58.75% |
100%                                    320/320 [00:00<00:00, 550.16it/s]
| Epoch: 180 | Train Loss: 1.317 | Train Acc: 72.66% | Val. Loss: 1.474 | Val. Acc: 56.88% |
100%                                    320/320 [00:00<00:00, 575.66it/s]
| Epoch: 181 | Train Loss: 1.328 | Train Acc: 71.41% | Val. Loss: 1.439 | Val. Acc: 60.62% |
100%                                    320/320 [00:00<00:00, 539.93it/s]
| Epoch: 182 | Train Loss: 1.323 | Train Acc: 72.11% | Val. Loss: 1.457 | Val. Acc: 58.13% |
100%                                    320/320 [00:00<00:00, 520.22it/s]
| Epoch: 183 | Train Loss: 1.333 | Train Acc: 71.09% | Val. Loss: 1.461 | Val. Acc: 58.13% |
100%                                    320/320 [00:00<00:00, 591.65it/s]
| Epoch: 184 | Train Loss: 1.325 | Train Acc: 71.80% | Val. Loss: 1.452 | Val. Acc: 59.38% |
100%                                    320/320 [00:00<00:00, 568.16it/s]
| Epoch: 185 | Train Loss: 1.321 | Train Acc: 72.27% | Val. Loss: 1.463 | Val. Acc: 58.13% |
100%                                    320/320 [00:00<00:00, 508.39it/s]
| Epoch: 186 | Train Loss: 1.323 | Train Acc: 72.03% | Val. Loss: 1.461 | Val. Acc: 58.13% |
100%                                    320/320 [00:00<00:00, 580.04it/s]
| Epoch: 187 | Train Loss: 1.315 | Train Acc: 72.81% | Val. Loss: 1.457 | Val. Acc: 58.75% |
100%                                    320/320 [00:00<00:00, 475.67it/s]
| Epoch: 188 | Train Loss: 1.318 | Train Acc: 72.58% | Val. Loss: 1.442 | Val. Acc: 60.00% |
100%                                    320/320 [00:00<00:00, 554.40it/s]
| Epoch: 189 | Train Loss: 1.329 | Train Acc: 71.41% | Val. Loss: 1.449 | Val. Acc: 59.38% |
100%                                    320/320 [00:00<00:00, 590.22it/s]
| Epoch: 190 | Train Loss: 1.324 | Train Acc: 71.95% | Val. Loss: 1.451 | Val. Acc: 59.38% |
100%                                    320/320 [00:00<00:00, 384.54it/s]
| Epoch: 191 | Train Loss: 1.322 | Train Acc: 72.19% | Val. Loss: 1.444 | Val. Acc: 60.00% |
100%                                    320/320 [00:00<00:00, 454.38it/s]
| Epoch: 192 | Train Loss: 1.325 | Train Acc: 71.88% | Val. Loss: 1.453 | Val. Acc: 58.75% |
100%                                    320/320 [00:00<00:00, 326.35it/s]
| Epoch: 193 | Train Loss: 1.322 | Train Acc: 72.11% | Val. Loss: 1.456 | Val. Acc: 58.75% |
100%                                    320/320 [00:00<00:00, 384.69it/s]
| Epoch: 194 | Train Loss: 1.327 | Train Acc: 71.64% | Val. Loss: 1.457 | Val. Acc: 58.75% |
100%                                    320/320 [00:00<00:00, 327.39it/s]
| Epoch: 195 | Train Loss: 1.327 | Train Acc: 71.64% | Val. Loss: 1.465 | Val. Acc: 58.13% |
100%                                    320/320 [00:00<00:00, 372.69it/s]
| Epoch: 196 | Train Loss: 1.330 | Train Acc: 71.33% | Val. Loss: 1.463 | Val. Acc: 58.13% |
100%                                    320/320 [00:00<00:00, 526.49it/s]
| Epoch: 197 | Train Loss: 1.323 | Train Acc: 72.03% | Val. Loss: 1.450 | Val. Acc: 59.38% |
100%                                    320/320 [00:00<00:00, 552.83it/s]
| Epoch: 198 | Train Loss: 1.318 | Train Acc: 72.58% | Val. Loss: 1.450 | Val. Acc: 59.38% |
100%                                    320/320 [00:00<00:00, 552.30it/s]
| Epoch: 199 | Train Loss: 1.324 | Train Acc: 71.95% | Val. Loss: 1.446 | Val. Acc: 59.38% |
100%                                    320/320 [00:00<00:00, 541.30it/s]
| Epoch: 200 | Train Loss: 1.317 | Train Acc: 72.73% | Val. Loss: 1.447 | Val. Acc: 59.38% |
| Test Loss: 1.416 | Test Acc: 62.71% |
```

```
from sklearn.metrics import precision_score, recall_score, f1_score

# Function to evaluate the model on the test set
def test_evaluate(model, data_loader, criterion):
    epoch_loss = 0
    epoch_acc = 0
    all_preds = []
    all_labels = []

    model.eval()
    with torch.no_grad():
        for d in data_loader:
            inputs = d['features'].to(device)
            labels = d['labels'].to(device)
            outputs = model(inputs)

            _, preds = torch.max(outputs, dim=1)
            loss = criterion(outputs, labels)
            acc = accuracy(outputs, labels)

            epoch_loss += loss.item()
            epoch_acc += acc.item()

            # Collect predictions and true labels for metric calculation
            all_preds.extend(preds.cpu().numpy())
            all_labels.extend(labels.cpu().numpy())

    # Calculate precision, recall, and F1-score
    precision = precision_score(all_labels, all_preds, average='weighted')
    recall = recall_score(all_labels, all_preds, average='weighted')
    f1 = f1_score(all_labels, all_preds, average='weighted')

    return epoch_loss / len(data_loader), epoch_acc / len(data_loader), precision, recall, f1

# After training, evaluate the new model on the test set
test_loss, test_acc, precision, recall, f1 = test_evaluate(winemodel, test_dataloader, criterion)

print(f'| Test Loss: {test_loss:.3f} | Test Acc: {test_acc*100:.2f}% | Precision: {precision:.2f} | Recall: {recall:.2f} | F1-score: {f1:.2f
```

```
| Test Loss: 1.405 | Test Acc: 64.17% | Precision: 0.61 | Recall: 0.64 | F1-score: 0.62 |
/usr/local/lib/python3.10/dist-packages/torch/nn/modules/module.py:1553: UserWarning: Implicit dimension choice for softmax has been dep
  return self._call_impl(*args, **kwargs)
/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1471: UndefinedMetricWarning: Precision is ill-defined and be
  _warn_prf(average, modifier, msg_start, len(result))
```

Enhancement 4: Increase the width of your model's layers. Report the parts of the model definition you had to update. Report results.

Model Updates:

For **Enhancement 4**, we increased the **width** of the model's layers to give the network more capacity to learn complex patterns. Here's a summary of the changes made to the model definition:

Parts of the Model Definition Updated:

1. **Increased the number of neurons** in each of the hidden layers:

   - `fc1` **layer**: Increased from 128 neurons to **256** neurons.
   - `fc2` **layer**: Increased from 64 neurons to **128** neurons.
   - `fc3` **layer**: Increased from 32 neurons to **64** neurons.

Final Results:

Summary of Model Performance: Test Loss: 1.405 — Indicates the average error the model made on the test set. A lower loss generally signifies better performance, though it must be evaluated with other metrics.

Test Accuracy: 64.17% — The model correctly classified 64.17% of the test data. This suggests that the model is moderately accurate but still misclassifies over 35% of the data.

Precision: 0.61 — Of all the positive predictions made by the model, 61% were correct. This metric indicates the model's ability to avoid false positives.

Recall: 0.64 — The model correctly identified 64% of the actual positive cases. This shows how well the model can detect true positives but also that it missed 36% of them.

F1-Score: 0.62 — The F1-score balances precision and recall, providing a harmonic mean. A score of 0.62 suggests moderate performance, with room for improvement in both detecting true positives and avoiding false positives.

```python
class WineModel(nn.Module):
    def __init__(self):
        super(WineModel, self).__init__()
        # Increased width of the layers
        self.fc1 = nn.Linear(input_size, 256)  # Increased width from 128 to 256
        self.fc2 = nn.Linear(256, 128)         # Increased width from 64 to 128
        self.fc3 = nn.Linear(128, 64)          # Increased width from 32 to 64
        self.fc4 = nn.Linear(64, num_classes)  # Output layer remains the same

    def forward(self, x):
        x = F.relu(self.fc1(x))
        x = F.relu(self.fc2(x))
        x = F.relu(self.fc3(x))
        x = self.fc4(x)
        return x



# Re-initialize the optimizer since we have updated the model
optimizer = Adam(winemodel.parameters(), lr=5e-3)  # You can adjust the learning rate if needed

# Number of epochs (you can try 200 again or adjust as needed)
num_epochs = 200

# Training loop
for epoch in range(num_epochs):
    train_loss, train_acc = train(winemodel, train_dataloader, optimizer, criterion)
    valid_loss, valid_acc = evaluate(winemodel, val_dataloader, criterion)

    print(f'| Epoch: {epoch+1:02} | Train Loss: {train_loss:.3f} | Train Acc: {train_acc*100:.2f}% | Val. Loss: {valid_loss:.3f} | Val. Acc:

# Evaluate on the test set after training
test_loss, test_acc = test_evaluate(winemodel, test_dataloader, criterion)

print(f'| Test Loss: {test_loss:.3f} | Test Acc: {test_acc*100:.2f}% |')
```

100%   320/320 [00:00<00:00, 589.38it/s]

| Epoch: 01 | Train Loss: 1.320 | Train Acc: 72.42% | Val. Loss: 1.437 | Val. Acc: 60.62% |

100%   320/320 [00:00<00:00, 482.30it/s]

| Epoch: 02 | Train Loss: 1.316 | Train Acc: 72.81% | Val. Loss: 1.443 | Val. Acc: 60.00% |

100%   320/320 [00:00<00:00, 355.88it/s]

| Epoch: 03 | Train Loss: 1.317 | Train Acc: 72.58% | Val. Loss: 1.448 | Val. Acc: 59.38% |

100%   320/320 [00:00<00:00, 490.85it/s]

| Epoch: 04 | Train Loss: 1.317 | Train Acc: 72.66% | Val. Loss: 1.439 | Val. Acc: 60.62% |

100%   320/320 [00:00<00:00, 409.36it/s]

| Epoch: 05 | Train Loss: 1.314 | Train Acc: 72.97% | Val. Loss: 1.441 | Val. Acc: 60.00% |

100%   320/320 [00:00<00:00, 480.44it/s]

| Epoch: 06 | Train Loss: 1.323 | Train Acc: 72.03% | Val. Loss: 1.435 | Val. Acc: 60.62% |

100%   320/320 [00:00<00:00, 685.02it/s]

| Epoch: 07 | Train Loss: 1.326 | Train Acc: 71.80% | Val. Loss: 1.434 | Val. Acc: 61.25% |

100%   320/320 [00:00<00:00, 539.70it/s]

| Epoch: 08 | Train Loss: 1.322 | Train Acc: 72.11% | Val. Loss: 1.434 | Val. Acc: 60.62% |

100%   320/320 [00:00<00:00, 578.48it/s]

| Epoch: 09 | Train Loss: 1.318 | Train Acc: 72.58% | Val. Loss: 1.441 | Val. Acc: 60.00% |

100%   320/320 [00:00<00:00, 654.40it/s]

| Epoch: 10 | Train Loss: 1.314 | Train Acc: 72.97% | Val. Loss: 1.447 | Val. Acc: 59.38% |

100%   320/320 [00:00<00:00, 660.01it/s]

| Epoch: 11 | Train Loss: 1.314 | Train Acc: 72.97% | Val. Loss: 1.450 | Val. Acc: 59.38% |

100%   320/320 [00:00<00:00, 537.43it/s]

| Epoch: 12 | Train Loss: 1.322 | Train Acc: 72.11% | Val. Loss: 1.450 | Val. Acc: 59.38% |

100%   320/320 [00:00<00:00, 629.56it/s]

| Epoch: 13 | Train Loss: 1.324 | Train Acc: 71.88% | Val. Loss: 1.451 | Val. Acc: 59.38% |

100%   320/320 [00:00<00:00, 686.28it/s]

| Epoch: 14 | Train Loss: 1.324 | Train Acc: 71.95% | Val. Loss: 1.446 | Val. Acc: 59.38% |

100%   320/320 [00:00<00:00, 534.69it/s]

| Epoch: 15 | Train Loss: 1.317 | Train Acc: 72.66% | Val. Loss: 1.448 | Val. Acc: 59.38% |

100%   320/320 [00:00<00:00, 619.06it/s]

| Epoch: 16 | Train Loss: 1.312 | Train Acc: 73.12% | Val. Loss: 1.447 | Val. Acc: 59.38% |

100%   320/320 [00:00<00:00, 660.32it/s]

| Epoch: 17 | Train Loss: 1.312 | Train Acc: 73.20% | Val. Loss: 1.440 | Val. Acc: 60.62% |

100%   320/320 [00:00<00:00, 625.70it/s]

| Epoch: 18 | Train Loss: 1.314 | Train Acc: 72.81% | Val. Loss: 1.454 | Val. Acc: 58.75% |

100%   320/320 [00:00<00:00, 527.69it/s]

| Epoch: 19 | Train Loss: 1.310 | Train Acc: 73.36% | Val. Loss: 1.464 | Val. Acc: 57.50% |

100%   320/320 [00:00<00:00, 668.03it/s]

| Epoch: 20 | Train Loss: 1.311 | Train Acc: 73.28% | Val. Loss: 1.464 | Val. Acc: 57.50% |

100%   320/320 [00:00<00:00, 694.60it/s]

| Epoch: 21 | Train Loss: 1.310 | Train Acc: 73.36% | Val. Loss: 1.463 | Val. Acc: 57.50% |

100%   320/320 [00:00<00:00, 520.68it/s]

| Epoch: 22 | Train Loss: 1.310 | Train Acc: 73.36% | Val. Loss: 1.463 | Val. Acc: 57.50% |

100%   320/320 [00:00<00:00, 636.61it/s]

| Epoch: 23 | Train Loss: 1.310 | Train Acc: 73.36% | Val. Loss: 1.462 | Val. Acc: 57.50% |

100%   320/320 [00:00<00:00, 481.16it/s]

| Epoch: 24 | Train Loss: 1.310 | Train Acc: 73.36% | Val. Loss: 1.460 | Val. Acc: 58.13% |

100%   320/320 [00:00<00:00, 408.17it/s]

| Epoch: 25 | Train Loss: 1.314 | Train Acc: 72.97% | Val. Loss: 1.468 | Val. Acc: 57.50% |

100%   320/320 [00:00<00:00, 436.64it/s]

| Epoch: 26 | Train Loss: 1.331 | Train Acc: 71.25% | Val. Loss: 1.445 | Val. Acc: 60.00% |

100%   320/320 [00:00<00:00, 372.37it/s]

| Epoch: 27 | Train Loss: 1.339 | Train Acc: 70.39% | Val. Loss: 1.448 | Val. Acc: 59.38% |

100%   320/320 [00:00<00:00, 528.75it/s]

| Epoch: 28 | Train Loss: 1.333 | Train Acc: 71.09% | Val. Loss: 1.457 | Val. Acc: 58.13% |

100%   320/320 [00:00<00:00, 644.19it/s]

| Epoch: 29 | Train Loss: 1.332 | Train Acc: 71.09% | Val. Loss: 1.455 | Val. Acc: 58.75% |

100%   320/320 [00:00<00:00, 575.47it/s]

```
| Epoch: 30 | Train Loss: 1.323 | Train Acc: 72.03% | Val. Loss: 1.456 | Val. Acc: 58.75% |
100%                                320/320 [00:00<00:00, 517.17it/s]
| Epoch: 31 | Train Loss: 1.323 | Train Acc: 71.95% | Val. Loss: 1.450 | Val. Acc: 59.38% |
100%                                320/320 [00:00<00:00, 636.68it/s]
| Epoch: 32 | Train Loss: 1.318 | Train Acc: 72.50% | Val. Loss: 1.444 | Val. Acc: 60.00% |
100%                                320/320 [00:00<00:00, 590.15it/s]
| Epoch: 33 | Train Loss: 1.323 | Train Acc: 72.03% | Val. Loss: 1.444 | Val. Acc: 60.00% |
100%                                320/320 [00:00<00:00, 531.78it/s]
| Epoch: 34 | Train Loss: 1.318 | Train Acc: 72.50% | Val. Loss: 1.447 | Val. Acc: 60.00% |
100%                                320/320 [00:00<00:00, 531.75it/s]
| Epoch: 35 | Train Loss: 1.318 | Train Acc: 72.58% | Val. Loss: 1.439 | Val. Acc: 60.00% |
100%                                320/320 [00:00<00:00, 686.49it/s]
| Epoch: 36 | Train Loss: 1.314 | Train Acc: 72.97% | Val. Loss: 1.438 | Val. Acc: 60.62% |
100%                                320/320 [00:00<00:00, 513.09it/s]
| Epoch: 37 | Train Loss: 1.314 | Train Acc: 72.97% | Val. Loss: 1.438 | Val. Acc: 60.62% |
100%                                320/320 [00:00<00:00, 571.97it/s]
| Epoch: 38 | Train Loss: 1.314 | Train Acc: 72.97% | Val. Loss: 1.439 | Val. Acc: 60.62% |
100%                                320/320 [00:00<00:00, 563.24it/s]
| Epoch: 39 | Train Loss: 1.314 | Train Acc: 72.97% | Val. Loss: 1.439 | Val. Acc: 60.62% |
100%                                320/320 [00:00<00:00, 554.11it/s]
| Epoch: 40 | Train Loss: 1.316 | Train Acc: 72.81% | Val. Loss: 1.441 | Val. Acc: 60.00% |
100%                                320/320 [00:00<00:00, 630.09it/s]
| Epoch: 41 | Train Loss: 1.323 | Train Acc: 72.03% | Val. Loss: 1.432 | Val. Acc: 61.25% |
100%                                320/320 [00:00<00:00, 501.72it/s]
| Epoch: 42 | Train Loss: 1.317 | Train Acc: 72.66% | Val. Loss: 1.432 | Val. Acc: 61.25% |
100%                                320/320 [00:00<00:00, 523.70it/s]
| Epoch: 43 | Train Loss: 1.320 | Train Acc: 72.34% | Val. Loss: 1.452 | Val. Acc: 58.75% |
100%                                320/320 [00:00<00:00, 674.35it/s]
| Epoch: 44 | Train Loss: 1.322 | Train Acc: 72.19% | Val. Loss: 1.445 | Val. Acc: 60.00% |
100%                                320/320 [00:00<00:00, 364.52it/s]
| Epoch: 45 | Train Loss: 1.333 | Train Acc: 71.02% | Val. Loss: 1.456 | Val. Acc: 58.75% |
100%                                320/320 [00:00<00:00, 501.03it/s]
| Epoch: 46 | Train Loss: 1.331 | Train Acc: 71.33% | Val. Loss: 1.469 | Val. Acc: 57.50% |
100%                                320/320 [00:00<00:00, 355.54it/s]
| Epoch: 47 | Train Loss: 1.329 | Train Acc: 71.41% | Val. Loss: 1.483 | Val. Acc: 56.25% |
100%                                320/320 [00:00<00:00, 438.05it/s]
| Epoch: 48 | Train Loss: 1.327 | Train Acc: 71.64% | Val. Loss: 1.453 | Val. Acc: 58.75% |
100%                                320/320 [00:00<00:00, 588.40it/s]
| Epoch: 49 | Train Loss: 1.317 | Train Acc: 72.58% | Val. Loss: 1.453 | Val. Acc: 59.38% |
100%                                320/320 [00:00<00:00, 498.85it/s]
| Epoch: 50 | Train Loss: 1.315 | Train Acc: 72.89% | Val. Loss: 1.455 | Val. Acc: 58.75% |
100%                                320/320 [00:00<00:00, 603.53it/s]
| Epoch: 51 | Train Loss: 1.318 | Train Acc: 72.58% | Val. Loss: 1.455 | Val. Acc: 58.75% |
100%                                320/320 [00:00<00:00, 658.81it/s]
| Epoch: 52 | Train Loss: 1.329 | Train Acc: 71.33% | Val. Loss: 1.439 | Val. Acc: 60.62% |
100%                                320/320 [00:00<00:00, 506.14it/s]
| Epoch: 53 | Train Loss: 1.323 | Train Acc: 72.03% | Val. Loss: 1.457 | Val. Acc: 58.75% |
100%                                320/320 [00:00<00:00, 648.88it/s]
| Epoch: 54 | Train Loss: 1.314 | Train Acc: 72.97% | Val. Loss: 1.462 | Val. Acc: 58.13% |
100%                                320/320 [00:00<00:00, 652.57it/s]
| Epoch: 55 | Train Loss: 1.314 | Train Acc: 72.97% | Val. Loss: 1.462 | Val. Acc: 58.13% |
100%                                320/320 [00:00<00:00, 511.49it/s]
| Epoch: 56 | Train Loss: 1.314 | Train Acc: 72.97% | Val. Loss: 1.462 | Val. Acc: 58.13% |
100%                                320/320 [00:00<00:00, 498.14it/s]
| Epoch: 57 | Train Loss: 1.314 | Train Acc: 72.97% | Val. Loss: 1.461 | Val. Acc: 58.13% |
100%                                320/320 [00:00<00:00, 620.96it/s]
| Epoch: 58 | Train Loss: 1.314 | Train Acc: 72.97% | Val. Loss: 1.461 | Val. Acc: 58.13% |
100%                                320/320 [00:00<00:00, 533.87it/s]
| Epoch: 59 | Train Loss: 1.314 | Train Acc: 72.97% | Val. Loss: 1.460 | Val. Acc: 58.13% |
100%                                320/320 [00:00<00:00, 544.81it/s]
```

```
| Epoch: 60 | Train Loss: 1.314 | Train Acc: 72.97% | Val. Loss: 1.459 | Val. Acc: 58.13% |
100%                                    320/320 [00:00<00:00, 666.12it/s]
| Epoch: 61 | Train Loss: 1.314 | Train Acc: 72.97% | Val. Loss: 1.462 | Val. Acc: 58.13% |
100%                                    320/320 [00:00<00:00, 564.21it/s]
| Epoch: 62 | Train Loss: 1.325 | Train Acc: 71.88% | Val. Loss: 1.518 | Val. Acc: 52.50% |
100%                                    320/320 [00:00<00:00, 468.38it/s]
| Epoch: 63 | Train Loss: 1.339 | Train Acc: 70.47% | Val. Loss: 1.462 | Val. Acc: 58.13% |
100%                                    320/320 [00:00<00:00, 612.54it/s]
| Epoch: 64 | Train Loss: 1.330 | Train Acc: 71.41% | Val. Loss: 1.457 | Val. Acc: 58.75% |
100%                                    320/320 [00:00<00:00, 388.93it/s]
| Epoch: 65 | Train Loss: 1.325 | Train Acc: 71.88% | Val. Loss: 1.444 | Val. Acc: 60.00% |
100%                                    320/320 [00:00<00:00, 415.54it/s]
| Epoch: 66 | Train Loss: 1.320 | Train Acc: 72.42% | Val. Loss: 1.447 | Val. Acc: 59.38% |
100%                                    320/320 [00:00<00:00, 402.78it/s]
| Epoch: 67 | Train Loss: 1.326 | Train Acc: 71.72% | Val. Loss: 1.467 | Val. Acc: 57.50% |
100%                                    320/320 [00:00<00:00, 386.77it/s]
| Epoch: 68 | Train Loss: 1.326 | Train Acc: 71.80% | Val. Loss: 1.447 | Val. Acc: 59.38% |
100%                                    320/320 [00:00<00:00, 463.52it/s]
| Epoch: 69 | Train Loss: 1.328 | Train Acc: 71.48% | Val. Loss: 1.432 | Val. Acc: 61.25% |
100%                                    320/320 [00:00<00:00, 485.28it/s]
| Epoch: 70 | Train Loss: 1.324 | Train Acc: 71.95% | Val. Loss: 1.445 | Val. Acc: 60.00% |
100%                                    320/320 [00:00<00:00, 560.52it/s]
| Epoch: 71 | Train Loss: 1.328 | Train Acc: 71.48% | Val. Loss: 1.458 | Val. Acc: 58.75% |
100%                                    320/320 [00:00<00:00, 562.10it/s]
| Epoch: 72 | Train Loss: 1.323 | Train Acc: 72.03% | Val. Loss: 1.477 | Val. Acc: 56.88% |
100%                                    320/320 [00:00<00:00, 557.17it/s]
| Epoch: 73 | Train Loss: 1.334 | Train Acc: 70.94% | Val. Loss: 1.462 | Val. Acc: 58.13% |
100%                                    320/320 [00:00<00:00, 585.61it/s]
| Epoch: 74 | Train Loss: 1.333 | Train Acc: 71.02% | Val. Loss: 1.450 | Val. Acc: 59.38% |
100%                                    320/320 [00:00<00:00, 495.84it/s]
| Epoch: 75 | Train Loss: 1.319 | Train Acc: 72.50% | Val. Loss: 1.450 | Val. Acc: 59.38% |
100%                                    320/320 [00:00<00:00, 519.60it/s]
| Epoch: 76 | Train Loss: 1.323 | Train Acc: 72.03% | Val. Loss: 1.459 | Val. Acc: 58.13% |
100%                                    320/320 [00:00<00:00, 612.44it/s]
| Epoch: 77 | Train Loss: 1.317 | Train Acc: 72.66% | Val. Loss: 1.453 | Val. Acc: 58.75% |
100%                                    320/320 [00:00<00:00, 475.30it/s]
| Epoch: 78 | Train Loss: 1.315 | Train Acc: 72.89% | Val. Loss: 1.462 | Val. Acc: 58.13% |
100%                                    320/320 [00:00<00:00, 550.11it/s]
| Epoch: 79 | Train Loss: 1.314 | Train Acc: 72.97% | Val. Loss: 1.455 | Val. Acc: 58.75% |
100%                                    320/320 [00:00<00:00, 632.67it/s]
| Epoch: 80 | Train Loss: 1.320 | Train Acc: 72.34% | Val. Loss: 1.506 | Val. Acc: 53.75% |
100%                                    320/320 [00:00<00:00, 509.31it/s]
| Epoch: 81 | Train Loss: 1.327 | Train Acc: 71.64% | Val. Loss: 1.469 | Val. Acc: 57.50% |
100%                                    320/320 [00:00<00:00, 553.09it/s]
| Epoch: 82 | Train Loss: 1.328 | Train Acc: 71.48% | Val. Loss: 1.464 | Val. Acc: 58.13% |
100%                                    320/320 [00:00<00:00, 660.84it/s]
| Epoch: 83 | Train Loss: 1.343 | Train Acc: 70.00% | Val. Loss: 1.471 | Val. Acc: 57.50% |
100%                                    320/320 [00:00<00:00, 502.05it/s]
| Epoch: 84 | Train Loss: 1.338 | Train Acc: 70.62% | Val. Loss: 1.507 | Val. Acc: 53.75% |
100%                                    320/320 [00:00<00:00, 460.07it/s]
| Epoch: 85 | Train Loss: 1.332 | Train Acc: 71.17% | Val. Loss: 1.474 | Val. Acc: 56.88% |
100%                                    320/320 [00:00<00:00, 446.31it/s]
| Epoch: 86 | Train Loss: 1.334 | Train Acc: 70.94% | Val. Loss: 1.478 | Val. Acc: 56.88% |
100%                                    320/320 [00:00<00:00, 384.62it/s]
| Epoch: 87 | Train Loss: 1.331 | Train Acc: 71.25% | Val. Loss: 1.475 | Val. Acc: 56.88% |
100%                                    320/320 [00:00<00:00, 407.78it/s]
| Epoch: 88 | Train Loss: 1.331 | Train Acc: 71.25% | Val. Loss: 1.478 | Val. Acc: 56.25% |
100%                                    320/320 [00:00<00:00, 422.90it/s]
| Epoch: 89 | Train Loss: 1.327 | Train Acc: 71.72% | Val. Loss: 1.462 | Val. Acc: 58.13% |
```

| Epoch: 90 | Train Loss: 1.326 | Train Acc: 71.80% | Val. Loss: 1.469 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 564.15it/s]
| Epoch: 91 | Train Loss: 1.324 | Train Acc: 71.95% | Val. Loss: 1.463 | Val. Acc: 58.13% |
100%   320/320 [00:00<00:00, 602.72it/s]
| Epoch: 92 | Train Loss: 1.323 | Train Acc: 72.03% | Val. Loss: 1.475 | Val. Acc: 56.88% |
100%   320/320 [00:00<00:00, 577.70it/s]
| Epoch: 93 | Train Loss: 1.324 | Train Acc: 71.95% | Val. Loss: 1.487 | Val. Acc: 55.62% |
100%   320/320 [00:00<00:00, 564.11it/s]
| Epoch: 94 | Train Loss: 1.316 | Train Acc: 72.73% | Val. Loss: 1.471 | Val. Acc: 56.88% |
100%   320/320 [00:00<00:00, 513.69it/s]
| Epoch: 95 | Train Loss: 1.322 | Train Acc: 72.19% | Val. Loss: 1.473 | Val. Acc: 56.88% |
100%   320/320 [00:00<00:00, 526.46it/s]
| Epoch: 96 | Train Loss: 1.327 | Train Acc: 71.64% | Val. Loss: 1.476 | Val. Acc: 56.25% |
100%   320/320 [00:00<00:00, 656.16it/s]
| Epoch: 97 | Train Loss: 1.316 | Train Acc: 72.73% | Val. Loss: 1.473 | Val. Acc: 56.88% |
100%   320/320 [00:00<00:00, 482.98it/s]
| Epoch: 98 | Train Loss: 1.317 | Train Acc: 72.66% | Val. Loss: 1.463 | Val. Acc: 58.13% |
100%   320/320 [00:00<00:00, 525.03it/s]
| Epoch: 99 | Train Loss: 1.321 | Train Acc: 72.27% | Val. Loss: 1.476 | Val. Acc: 56.88% |
100%   320/320 [00:00<00:00, 633.74it/s]
| Epoch: 100 | Train Loss: 1.318 | Train Acc: 72.50% | Val. Loss: 1.449 | Val. Acc: 59.38% |
100%   320/320 [00:00<00:00, 499.23it/s]
| Epoch: 101 | Train Loss: 1.322 | Train Acc: 72.19% | Val. Loss: 1.450 | Val. Acc: 59.38% |
100%   320/320 [00:00<00:00, 581.50it/s]
| Epoch: 102 | Train Loss: 1.327 | Train Acc: 71.64% | Val. Loss: 1.456 | Val. Acc: 58.75% |
100%   320/320 [00:00<00:00, 590.74it/s]
| Epoch: 103 | Train Loss: 1.324 | Train Acc: 72.11% | Val. Loss: 1.463 | Val. Acc: 58.13% |
100%   320/320 [00:00<00:00, 524.92it/s]
| Epoch: 104 | Train Loss: 1.325 | Train Acc: 71.80% | Val. Loss: 1.450 | Val. Acc: 59.38% |
100%   320/320 [00:00<00:00, 518.55it/s]
| Epoch: 105 | Train Loss: 1.322 | Train Acc: 72.19% | Val. Loss: 1.445 | Val. Acc: 59.38% |
100%   320/320 [00:00<00:00, 428.22it/s]
| Epoch: 106 | Train Loss: 1.322 | Train Acc: 72.11% | Val. Loss: 1.450 | Val. Acc: 59.38% |
100%   320/320 [00:00<00:00, 512.03it/s]
| Epoch: 107 | Train Loss: 1.320 | Train Acc: 72.34% | Val. Loss: 1.465 | Val. Acc: 57.50% |
100%   320/320 [00:00<00:00, 364.39it/s]
| Epoch: 108 | Train Loss: 1.319 | Train Acc: 72.42% | Val. Loss: 1.443 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 443.38it/s]
| Epoch: 109 | Train Loss: 1.318 | Train Acc: 72.58% | Val. Loss: 1.444 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 529.54it/s]
| Epoch: 110 | Train Loss: 1.317 | Train Acc: 72.66% | Val. Loss: 1.444 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 558.12it/s]
| Epoch: 111 | Train Loss: 1.317 | Train Acc: 72.66% | Val. Loss: 1.444 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 624.95it/s]
| Epoch: 112 | Train Loss: 1.317 | Train Acc: 72.66% | Val. Loss: 1.444 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 585.27it/s]
| Epoch: 113 | Train Loss: 1.317 | Train Acc: 72.66% | Val. Loss: 1.444 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 486.04it/s]
| Epoch: 114 | Train Loss: 1.317 | Train Acc: 72.66% | Val. Loss: 1.444 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 571.20it/s]
| Epoch: 115 | Train Loss: 1.317 | Train Acc: 72.66% | Val. Loss: 1.444 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 582.68it/s]
| Epoch: 116 | Train Loss: 1.317 | Train Acc: 72.66% | Val. Loss: 1.444 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 536.72it/s]
| Epoch: 117 | Train Loss: 1.317 | Train Acc: 72.66% | Val. Loss: 1.444 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 583.63it/s]
| Epoch: 118 | Train Loss: 1.317 | Train Acc: 72.66% | Val. Loss: 1.445 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 605.15it/s]
| Epoch: 119 | Train Loss: 1.317 | Train Acc: 72.66% | Val. Loss: 1.445 | Val. Acc: 60.00% |

```
100%                              320/320 [00:00<00:00, 558.12it/s]
| Epoch: 120 | Train Loss: 1.317 | Train Acc: 72.66% | Val. Loss: 1.445 | Val. Acc: 60.00% |
100%                              320/320 [00:00<00:00, 533.30it/s]
| Epoch: 121 | Train Loss: 1.317 | Train Acc: 72.66% | Val. Loss: 1.445 | Val. Acc: 60.00% |
100%                              320/320 [00:00<00:00, 653.65it/s]
| Epoch: 122 | Train Loss: 1.317 | Train Acc: 72.66% | Val. Loss: 1.445 | Val. Acc: 60.00% |
100%                              320/320 [00:00<00:00, 477.54it/s]
| Epoch: 123 | Train Loss: 1.317 | Train Acc: 72.66% | Val. Loss: 1.445 | Val. Acc: 60.00% |
100%                              320/320 [00:00<00:00, 540.61it/s]
| Epoch: 124 | Train Loss: 1.317 | Train Acc: 72.66% | Val. Loss: 1.446 | Val. Acc: 60.00% |
100%                              320/320 [00:00<00:00, 587.07it/s]
| Epoch: 125 | Train Loss: 1.321 | Train Acc: 72.27% | Val. Loss: 1.451 | Val. Acc: 59.38% |
100%                              320/320 [00:00<00:00, 455.26it/s]
| Epoch: 126 | Train Loss: 1.331 | Train Acc: 71.17% | Val. Loss: 1.444 | Val. Acc: 60.00% |
100%                              320/320 [00:00<00:00, 393.30it/s]
| Epoch: 127 | Train Loss: 1.345 | Train Acc: 69.92% | Val. Loss: 1.453 | Val. Acc: 58.75% |
100%                              320/320 [00:00<00:00, 438.15it/s]
| Epoch: 128 | Train Loss: 1.334 | Train Acc: 71.02% | Val. Loss: 1.440 | Val. Acc: 60.62% |
100%                              320/320 [00:00<00:00, 363.93it/s]
| Epoch: 129 | Train Loss: 1.320 | Train Acc: 72.42% | Val. Loss: 1.434 | Val. Acc: 60.62% |
100%                              320/320 [00:00<00:00, 371.85it/s]
| Epoch: 130 | Train Loss: 1.321 | Train Acc: 72.34% | Val. Loss: 1.436 | Val. Acc: 60.62% |
100%                              320/320 [00:00<00:00, 526.09it/s]
| Epoch: 131 | Train Loss: 1.318 | Train Acc: 72.58% | Val. Loss: 1.439 | Val. Acc: 60.62% |
100%                              320/320 [00:00<00:00, 581.41it/s]
| Epoch: 132 | Train Loss: 1.318 | Train Acc: 72.58% | Val. Loss: 1.439 | Val. Acc: 60.62% |
100%                              320/320 [00:00<00:00, 575.92it/s]
| Epoch: 133 | Train Loss: 1.318 | Train Acc: 72.58% | Val. Loss: 1.439 | Val. Acc: 60.62% |
100%                              320/320 [00:00<00:00, 504.58it/s]
| Epoch: 134 | Train Loss: 1.318 | Train Acc: 72.58% | Val. Loss: 1.439 | Val. Acc: 60.62% |
100%                              320/320 [00:00<00:00, 599.65it/s]
| Epoch: 135 | Train Loss: 1.319 | Train Acc: 72.42% | Val. Loss: 1.448 | Val. Acc: 59.38% |
100%                              320/320 [00:00<00:00, 581.83it/s]
| Epoch: 136 | Train Loss: 1.332 | Train Acc: 71.09% | Val. Loss: 1.456 | Val. Acc: 58.75% |
100%                              320/320 [00:00<00:00, 563.38it/s]
| Epoch: 137 | Train Loss: 1.339 | Train Acc: 70.39% | Val. Loss: 1.460 | Val. Acc: 58.75% |
100%                              320/320 [00:00<00:00, 581.26it/s]
| Epoch: 138 | Train Loss: 1.362 | Train Acc: 68.28% | Val. Loss: 1.494 | Val. Acc: 55.00% |
100%                              320/320 [00:00<00:00, 614.84it/s]
| Epoch: 139 | Train Loss: 1.375 | Train Acc: 66.88% | Val. Loss: 1.505 | Val. Acc: 53.75% |
100%                              320/320 [00:00<00:00, 524.49it/s]
| Epoch: 140 | Train Loss: 1.405 | Train Acc: 63.83% | Val. Loss: 1.488 | Val. Acc: 55.62% |
100%                              320/320 [00:00<00:00, 508.49it/s]
| Epoch: 141 | Train Loss: 1.399 | Train Acc: 64.45% | Val. Loss: 1.505 | Val. Acc: 53.75% |
100%                              320/320 [00:00<00:00, 658.80it/s]
| Epoch: 142 | Train Loss: 1.379 | Train Acc: 66.48% | Val. Loss: 1.443 | Val. Acc: 60.00% |
100%                              320/320 [00:00<00:00, 494.68it/s]
| Epoch: 143 | Train Loss: 1.366 | Train Acc: 67.73% | Val. Loss: 1.437 | Val. Acc: 60.62% |
100%                              320/320 [00:00<00:00, 516.77it/s]
| Epoch: 144 | Train Loss: 1.359 | Train Acc: 68.44% | Val. Loss: 1.463 | Val. Acc: 58.13% |
100%                              320/320 [00:00<00:00, 607.26it/s]
| Epoch: 145 | Train Loss: 1.365 | Train Acc: 67.97% | Val. Loss: 1.469 | Val. Acc: 57.50% |
100%                              320/320 [00:00<00:00, 384.16it/s]
| Epoch: 146 | Train Loss: 1.358 | Train Acc: 68.52% | Val. Loss: 1.459 | Val. Acc: 58.13% |
100%                              320/320 [00:00<00:00, 510.13it/s]
| Epoch: 147 | Train Loss: 1.356 | Train Acc: 68.75% | Val. Loss: 1.463 | Val. Acc: 58.13% |
100%                              320/320 [00:00<00:00, 425.32it/s]
| Epoch: 148 | Train Loss: 1.358 | Train Acc: 68.59% | Val. Loss: 1.446 | Val. Acc: 59.38% |
100%                              320/320 [00:00<00:00, 395.14it/s]
| Epoch: 149 | Train Loss: 1.350 | Train Acc: 69.38% | Val. Loss: 1.457 | Val. Acc: 58.13% |
```

| Epoch: 149 | Train Loss: 1.336 | Train Acc: 69.38% | Val. Loss: 1.437 | Val. Acc: 50.13% |
100%   320/320 [00:00<00:00, 436.49it/s]
| Epoch: 150 | Train Loss: 1.343 | Train Acc: 70.08% | Val. Loss: 1.444 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 420.39it/s]
| Epoch: 151 | Train Loss: 1.342 | Train Acc: 70.23% | Val. Loss: 1.439 | Val. Acc: 60.62% |
100%   320/320 [00:00<00:00, 603.76it/s]
| Epoch: 152 | Train Loss: 1.343 | Train Acc: 70.08% | Val. Loss: 1.447 | Val. Acc: 59.38% |
100%   320/320 [00:00<00:00, 559.40it/s]
| Epoch: 153 | Train Loss: 1.333 | Train Acc: 71.09% | Val. Loss: 1.441 | Val. Acc: 60.62% |
100%   320/320 [00:00<00:00, 497.38it/s]
| Epoch: 154 | Train Loss: 1.328 | Train Acc: 71.48% | Val. Loss: 1.437 | Val. Acc: 60.62% |
100%   320/320 [00:00<00:00, 587.49it/s]
| Epoch: 155 | Train Loss: 1.328 | Train Acc: 71.41% | Val. Loss: 1.459 | Val. Acc: 58.13% |
100%   320/320 [00:00<00:00, 543.64it/s]
| Epoch: 156 | Train Loss: 1.321 | Train Acc: 72.19% | Val. Loss: 1.474 | Val. Acc: 56.88% |
100%   320/320 [00:00<00:00, 564.58it/s]
| Epoch: 157 | Train Loss: 1.318 | Train Acc: 72.50% | Val. Loss: 1.444 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 548.89it/s]
| Epoch: 158 | Train Loss: 1.317 | Train Acc: 72.73% | Val. Loss: 1.442 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 552.72it/s]
| Epoch: 159 | Train Loss: 1.319 | Train Acc: 72.50% | Val. Loss: 1.435 | Val. Acc: 60.62% |
100%   320/320 [00:00<00:00, 613.68it/s]
| Epoch: 160 | Train Loss: 1.327 | Train Acc: 71.64% | Val. Loss: 1.428 | Val. Acc: 61.88% |
100%   320/320 [00:00<00:00, 458.45it/s]
| Epoch: 161 | Train Loss: 1.322 | Train Acc: 72.11% | Val. Loss: 1.431 | Val. Acc: 61.25% |
100%   320/320 [00:00<00:00, 504.40it/s]
| Epoch: 162 | Train Loss: 1.318 | Train Acc: 72.66% | Val. Loss: 1.435 | Val. Acc: 61.25% |
100%   320/320 [00:00<00:00, 612.26it/s]
| Epoch: 163 | Train Loss: 1.318 | Train Acc: 72.50% | Val. Loss: 1.441 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 463.04it/s]
| Epoch: 164 | Train Loss: 1.316 | Train Acc: 72.73% | Val. Loss: 1.438 | Val. Acc: 60.62% |
100%   320/320 [00:00<00:00, 517.14it/s]
| Epoch: 165 | Train Loss: 1.314 | Train Acc: 72.97% | Val. Loss: 1.440 | Val. Acc: 60.62% |
100%   320/320 [00:00<00:00, 527.82it/s]
| Epoch: 166 | Train Loss: 1.313 | Train Acc: 73.05% | Val. Loss: 1.439 | Val. Acc: 60.62% |
100%   320/320 [00:00<00:00, 423.20it/s]
| Epoch: 167 | Train Loss: 1.313 | Train Acc: 73.05% | Val. Loss: 1.442 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 486.07it/s]
| Epoch: 168 | Train Loss: 1.329 | Train Acc: 71.48% | Val. Loss: 1.493 | Val. Acc: 55.00% |
100%   320/320 [00:00<00:00, 435.72it/s]
| Epoch: 169 | Train Loss: 1.325 | Train Acc: 71.80% | Val. Loss: 1.446 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 358.75it/s]
| Epoch: 170 | Train Loss: 1.324 | Train Acc: 71.88% | Val. Loss: 1.437 | Val. Acc: 60.62% |
100%   320/320 [00:00<00:00, 438.96it/s]
| Epoch: 171 | Train Loss: 1.318 | Train Acc: 72.50% | Val. Loss: 1.445 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 425.31it/s]
| Epoch: 172 | Train Loss: 1.320 | Train Acc: 72.34% | Val. Loss: 1.444 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 597.84it/s]
| Epoch: 173 | Train Loss: 1.324 | Train Acc: 71.95% | Val. Loss: 1.444 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 505.62it/s]
| Epoch: 174 | Train Loss: 1.319 | Train Acc: 72.42% | Val. Loss: 1.444 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 583.70it/s]
| Epoch: 175 | Train Loss: 1.318 | Train Acc: 72.58% | Val. Loss: 1.444 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 568.26it/s]
| Epoch: 176 | Train Loss: 1.319 | Train Acc: 72.50% | Val. Loss: 1.444 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 542.68it/s]
| Epoch: 177 | Train Loss: 1.322 | Train Acc: 72.11% | Val. Loss: 1.449 | Val. Acc: 59.38% |
100%   320/320 [00:00<00:00, 614.32it/s]
| Epoch: 178 | Train Loss: 1.322 | Train Acc: 72.11% | Val. Loss: 1.445 | Val. Acc: 60.00% |
100%   320/320 [00:00<00:00, 530.77it/s]

```
| Epoch: 179 | Train Loss: 1.315 | Train Acc: 72.81% | Val. Loss: 1.444 | Val. Acc: 60.00% |
100%                                320/320 [00:00<00:00, 550.23it/s]
| Epoch: 180 | Train Loss: 1.322 | Train Acc: 72.27% | Val. Loss: 1.435 | Val. Acc: 60.62% |
100%                                320/320 [00:00<00:00, 650.24it/s]
| Epoch: 181 | Train Loss: 1.340 | Train Acc: 70.39% | Val. Loss: 1.468 | Val. Acc: 57.50% |
100%                                320/320 [00:00<00:00, 496.61it/s]
| Epoch: 182 | Train Loss: 1.335 | Train Acc: 70.78% | Val. Loss: 1.447 | Val. Acc: 59.38% |
100%                                320/320 [00:00<00:00, 552.11it/s]
| Epoch: 183 | Train Loss: 1.329 | Train Acc: 71.41% | Val. Loss: 1.449 | Val. Acc: 59.38% |
100%                                320/320 [00:00<00:00, 626.43it/s]
| Epoch: 184 | Train Loss: 1.333 | Train Acc: 71.09% | Val. Loss: 1.468 | Val. Acc: 57.50% |
100%                                320/320 [00:00<00:00, 494.40it/s]
| Epoch: 185 | Train Loss: 1.336 | Train Acc: 70.70% | Val. Loss: 1.447 | Val. Acc: 59.38% |
100%                                320/320 [00:00<00:00, 529.75it/s]
| Epoch: 186 | Train Loss: 1.324 | Train Acc: 71.95% | Val. Loss: 1.450 | Val. Acc: 59.38% |
100%                                320/320 [00:00<00:00, 608.72it/s]
| Epoch: 187 | Train Loss: 1.325 | Train Acc: 71.80% | Val. Loss: 1.450 | Val. Acc: 59.38% |
```