

Learnable Positional Encoding

June 10, 2023

```
[1]: import torch
import torch.nn as nn
from torch.utils.data import Dataset, DataLoader
```

```
[2]: sequence_length = 20
```

```
[3]: class PatientDataset(Dataset):
    def __init__(self, num_patients, sequence_length, num_features):
        self.num_patients = num_patients
        self.sequence_length = sequence_length
        self.num_features = num_features

    def __len__(self):
        return self.num_patients

    def __getitem__(self, idx):
        heart_rate = torch.randint(low = 40, high = 140, size = (self.
↪sequence_length, 1))
        heart_condition = torch.randint(low = 0, high = 4, size = (self.
↪sequence_length, 1))
        pulse_rate = torch.randint(low = 60, high = 120, size = (self.
↪sequence_length, 1))
        oxygen_level = torch.randint(low = 80, high = 100, size = (self.
↪sequence_length, 1))
        medical_factors = torch.randn(self.sequence_length, self.num_features -
↪4, dtype=torch.float32)

        sequence = torch.cat((heart_rate, heart_condition, pulse_rate,
↪oxygen_level, medical_factors), dim=1)
        return sequence

pdata = PatientDataset(num_patients = 100, sequence_length = 20, num_features =
↪5)
```

```
[4]: len(pdata)
```

```
[4]: 100
```

```
[5]: pdata[1]
```

```
[5]: tensor([[ 4.9000e+01,  0.0000e+00,  1.0300e+02,  8.9000e+01, -1.6359e+00],
           [ 5.4000e+01,  3.0000e+00,  6.8000e+01,  9.5000e+01, -1.4221e+00],
           [ 5.3000e+01,  3.0000e+00,  1.0300e+02,  8.7000e+01,  8.2934e-01],
           [ 9.3000e+01,  0.0000e+00,  1.0700e+02,  9.6000e+01, -1.5719e-02],
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           [ 1.1400e+02,  0.0000e+00,  1.0100e+02,  8.6000e+01, -9.8534e-01]])
```

```
[6]: batch_size = 16
     embedding_dim = 5
```

```
[7]: class LearnablePositionalEncoding(nn.Module):
      def __init__(self, sequence_length, embedding_dim):
          super(LearnablePositionalEncoding, self).__init__()
          self.position_embeddings = nn.Parameter(torch.randn(sequence_length,
          ↪ embedding_dim))

      def forward(self, input_ids):
          seq_length = input_ids.size(1)
          position_ids = torch.arange(seq_length, dtype=torch.long,
          ↪ device=input_ids.device)
          position_embeddings = self.position_embeddings[position_ids]
          return input_ids + position_embeddings
```

```
[8]: from torch.optim import Adam

     num_epochs = 5
```

```
[9]: data_loader = DataLoader(pdata, batch_size=batch_size, shuffle=True)

     LearnPE = LearnablePositionalEncoding(sequence_length, embedding_dim)
     criterion = nn.MSELoss()
```

```

optimizer = Adam(LearnPE.parameters(), lr=0.001)

# learn_pe_optimizer = torch.optim.Adam(LearnPE.parameters(), lr=0.001)
# actual_model_optimizer = torch.optim.Adam(actual_model.parameters(), lr=0.001)
# combined_params = list(LearnPE.parameters()) + list(actual_model.parameters())
# optimizer = torch.optim.Adam(combined_params, lr=0.001)

for epoch in range(num_epochs):
    for batch in data_loader:
        optimizer.zero_grad()

        input_ids = batch
        encoded_data = LearnPE(input_ids)

        #output = actual_model(encoded_data)
        #loss = criterion(output, target)
        # loss.backward()
        # optimizer.step()

        print(encoded_data)
        # print(loss.item())

    print(f"Epoch {epoch + 1}/{num_epochs} completed")

```

```

tensor([[[ 44.5234,   3.6773, 113.9422,  96.9759, -0.6214],
         [ 68.1214,   2.6005, 118.5694,  84.3657, -0.6933],
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         ...,
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        [[ 46.5234,   2.6773, 111.9422,  84.9759, -1.0367],
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grad_fn=<AddBackward0>)
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 [ 1.0046e+02,  2.6510e+00,  6.7324e+01,  8.1865e+01, -1.2439e-01]]],
grad_fn=<AddBackward0>)
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 [ 1.3346e+02,  1.6510e+00,  7.8324e+01,  8.7865e+01, -8.8786e-01]],

[[ 4.7523e+01,  4.6773e+00,  7.7942e+01,  8.1976e+01, -1.6631e+00],
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 [ 7.9997e+01,  3.5904e+00,  9.1779e+01,  9.1555e+01, -7.6317e-01],
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 [ 1.2746e+02,  2.6510e+00,  9.0324e+01,  8.3865e+01,  4.6521e-01]],

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 [ 4.8997e+01,  2.5904e+00,  1.0978e+02,  8.7555e+01, -5.2115e-01],
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 [ 8.8484e+01, -7.6387e-01,  6.4774e+01,  8.9108e+01, -3.2538e+00],
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 [ 1.1446e+02,  1.6510e+00,  6.9324e+01,  9.1865e+01, -5.8545e-01]]],
grad_fn=<AddBackward0>)
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 [ 7.7997e+01,  5.9037e-01,  1.1578e+02,  9.6555e+01, -1.0774e+00],
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 [ 1.0146e+02,  6.5095e-01,  9.0324e+01,  8.0865e+01, -5.3359e-01]],

[[ 5.6523e+01,  5.6773e+00,  1.1294e+02,  8.5976e+01, -1.4423e+00],
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grad_fn=<AddBackward0>)
Epoch 1/5 completed
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 [ 1.2346e+02,  3.6510e+00,  8.6324e+01,  9.0865e+01, -4.7119e-01]],

[[ 7.9523e+01,  2.6773e+00,  7.0942e+01,  8.9976e+01, -2.7867e-01],
 [ 4.8121e+01,  3.6005e+00,  1.0057e+02,  9.8366e+01,  5.1057e-01],
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 [ 1.2210e+02,  1.5757e+00,  8.8830e+01,  9.4786e+01,  7.3062e-01],
 [ 9.1484e+01,  2.2361e+00,  7.5774e+01,  8.3108e+01, -2.4911e+00],
 [ 1.2446e+02,  3.6510e+00,  7.9324e+01,  8.0865e+01,  1.6072e-01]],

[[ 1.2952e+02,  2.6773e+00,  9.3942e+01,  9.2976e+01, -7.3972e-02],
 [ 7.9121e+01,  6.0055e-01,  7.9569e+01,  8.0366e+01, -1.3909e+00],
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 [ 6.1484e+01,  2.2361e+00,  6.2774e+01,  9.6108e+01, -2.0555e+00],
 [ 1.0246e+02,  6.5095e-01,  6.5324e+01,  8.5865e+01, -5.2947e-01]]],
grad_fn=<AddBackward0>)
tensor([[[[ 9.1523e+01,  2.6773e+00,  1.0694e+02,  8.7976e+01, -2.0908e+00],
 [ 7.0121e+01,  6.0055e-01,  7.1569e+01,  9.6366e+01,  7.0919e-01],
 [ 1.3100e+02,  2.5904e+00,  9.6779e+01,  9.6555e+01, -1.5546e+00],
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 [ 1.1446e+02,  6.5095e-01,  9.8324e+01,  8.2865e+01, -1.2154e+00]],

[[ 1.1552e+02,  2.6773e+00,  8.9942e+01,  9.8976e+01,  1.0105e+00],
 [ 5.2121e+01,  1.6005e+00,  6.5569e+01,  9.1366e+01, -8.6874e-01],
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 [ 1.0646e+02,  6.5095e-01,  8.8324e+01,  8.0865e+01,  2.0538e-01]],

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[ 7.0484e+01,  2.2361e+00,  7.2774e+01,  8.8108e+01, -2.2885e+00],
[ 7.7464e+01,  2.6510e+00,  6.6324e+01,  8.2865e+01, -1.4195e+00]],
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 [ 4.7121e+01,  1.6005e+00,  1.1957e+02,  8.2366e+01,  8.7385e-01],
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 [ 4.9464e+01,  2.6510e+00,  6.4324e+01,  9.2865e+01, -8.9975e-02]],

[[ 6.4523e+01,  4.6773e+00,  6.8942e+01,  9.0976e+01, -1.0732e+00],
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 [ 4.8997e+01,  2.5904e+00,  9.8779e+01,  9.6555e+01,  1.3579e-01],
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 [ 1.0246e+02,  6.5095e-01,  6.1324e+01,  9.8865e+01,  1.1137e+00]],

[[ 1.1752e+02,  2.6773e+00,  8.7942e+01,  8.8976e+01, -1.6716e+00],
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 [ 5.1997e+01,  3.5904e+00,  6.7779e+01,  9.7555e+01, -8.8649e-01],
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 [ 5.9484e+01,  2.3613e-01,  8.3774e+01,  8.0108e+01, -1.4446e+00],
 [ 9.8464e+01,  2.6510e+00,  1.0432e+02,  8.9865e+01, -1.6021e+00]]],
grad_fn=<AddBackward0>)
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 [ 8.8121e+01,  2.6005e+00,  1.0257e+02,  9.9366e+01,  4.6521e-01],
 [ 1.2600e+02,  5.9037e-01,  8.1779e+01,  8.2555e+01, -2.0069e-01],
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 [ 4.6484e+01,  2.3613e-01,  8.0774e+01,  8.3108e+01, -2.7463e+00],
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[[ 1.2252e+02,  4.6773e+00,  8.4942e+01,  9.5976e+01, -5.8829e-01],
 [ 4.8121e+01,  3.6005e+00,  9.9569e+01,  9.3366e+01, -9.5178e-02],
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 [ 1.1348e+02,  2.2361e+00,  7.4774e+01,  8.9108e+01, -2.0531e-01],
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[[ 6.8523e+01,  3.6773e+00,  7.1942e+01,  9.2976e+01,  5.5074e-02],
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```

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[ 1.0348e+02,  2.3613e-01,  1.0977e+02,  9.0108e+01, -4.6192e-01],
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 [ 7.3464e+01,  6.5095e-01,  1.1132e+02,  8.2865e+01, -1.1637e-01]],

[[ 1.0552e+02,  4.6773e+00,  9.7942e+01,  9.1976e+01, -3.1046e+00],
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[[ 1.1752e+02,  5.6773e+00,  1.0894e+02,  8.0976e+01,  1.5158e+00],
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 [ 1.1246e+02,  1.6510e+00,  8.7324e+01,  8.0865e+01,  1.3601e+00]]],
grad_fn=<AddBackward0>)
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 [ 1.2246e+02,  6.5095e-01,  1.0532e+02,  9.6865e+01,  1.0433e+00]],

[[ 1.0352e+02,  2.6773e+00,  6.2942e+01,  8.1976e+01, -6.4589e-01],
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 [ 8.1484e+01,  2.3613e-01,  9.1774e+01,  8.1108e+01, -1.6964e+00],
 [ 1.2946e+02,  1.6510e+00,  6.0324e+01,  8.7865e+01,  1.1652e+00]],

```

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 [ 8.2997e+01,  2.5904e+00,  7.0779e+01,  8.2555e+01, -1.6913e+00],
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 [ 1.0400e+02,  5.9037e-01,  6.5779e+01,  8.7555e+01,  4.5687e-01],
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 [ 1.2300e+02,  1.5904e+00,  1.1178e+02,  8.0555e+01, -1.2154e+00],
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 [ 1.2348e+02, -7.6387e-01,  7.4774e+01,  9.0108e+01, -1.6181e+00],
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grad_fn=<AddBackward0>)
tensor([[[[ 7.7523e+01,  2.6773e+00,  6.3942e+01,  9.1976e+01,  1.7170e+00],
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 [ 1.0100e+02,  2.5904e+00,  1.0178e+02,  9.2555e+01, -2.1209e+00],
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 [ 6.5464e+01,  3.6510e+00,  1.0732e+02,  8.0865e+01, -4.5029e-02]],

[[ 7.4523e+01,  3.6773e+00,  1.1894e+02,  9.6976e+01,  4.6394e-01],
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 [ 1.3700e+02,  3.5904e+00,  8.1779e+01,  9.3555e+01,  1.1570e-01],
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```

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 [ 6.2464e+01,  2.6510e+00,  8.0324e+01,  9.1865e+01, -7.2758e-01]],

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[[ 4.6523e+01,  2.6773e+00,  6.5942e+01,  9.6976e+01,  7.1737e-01],
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 [ 6.4484e+01, -7.6387e-01,  1.1977e+02,  8.7108e+01, -1.4479e+00],
 [ 8.2464e+01,  2.6510e+00,  9.6324e+01,  8.7865e+01, -3.6825e+00]]],
grad_fn=<AddBackward0>)
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 [ 4.4484e+01,  2.2361e+00,  7.5774e+01,  9.2108e+01, -5.7404e-01],
 [ 1.3946e+02,  1.6510e+00,  1.0432e+02,  8.0865e+01, -2.4480e-01]],

[[ 9.2523e+01,  5.6773e+00,  9.3942e+01,  9.3976e+01,  9.3242e-01],
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 [ 6.2997e+01,  2.5904e+00,  8.0779e+01,  9.8555e+01, -1.1626e+00],
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```



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[ 9.2484e+01, 1.2361e+00, 1.1277e+02, 8.9108e+01, -3.1238e+00],
[ 6.3464e+01, 3.6510e+00, 8.3324e+01, 9.0865e+01, -8.4368e-01]],

[[ 1.3152e+02, 2.6773e+00, 6.4942e+01, 9.8976e+01, 7.7207e-01],
[ 6.9121e+01, 3.6005e+00, 8.2569e+01, 9.0366e+01, 6.4522e-01],
[ 1.1200e+02, 2.5904e+00, 1.0678e+02, 9.2555e+01, -4.0803e-02],
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[ 9.2097e+01, 5.7573e-01, 1.1483e+02, 8.8786e+01, 1.3810e+00],
[ 6.4484e+01, -7.6387e-01, 6.8774e+01, 8.2108e+01, -2.8140e+00],
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[ 1.2912e+02, 3.6005e+00, 8.4569e+01, 9.1366e+01, -2.4229e-01],
[ 1.3600e+02, 5.9037e-01, 7.9779e+01, 9.5555e+01, -8.4101e-01],
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[ 4.6464e+01, 2.6510e+00, 7.0324e+01, 9.6865e+01, 1.3030e+00]]],
grad_fn=<AddBackward0>)
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[ 1.0218e+02, 4.7146e+00, 7.4664e+01, 9.3309e+01, -9.3712e-01],
[ 9.2927e+01, 1.7672e+00, 6.2202e+01, 9.1003e+01, -8.2872e-01],
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[ 7.8656e+01, 1.4215e+00, 6.5885e+01, 8.1383e+01, -1.9708e-02],
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[ 1.2205e+02, -1.0500e+00,  6.6259e+01,  8.1309e+01,  2.0318e+00],
[ 1.3749e+02,  2.6586e+00,  8.7949e+01,  9.5111e+01, -1.9756e+00],
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grad_fn=<AddBackward0>)
Epoch 2/5 completed
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[[ 1.0552e+02,  5.6773e+00,  9.1942e+01,  8.3976e+01, -1.6311e+00],
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[ 4.1997e+01,  1.5904e+00,  1.1078e+02,  9.1555e+01,  2.2181e-01],
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[ 6.4464e+01,  6.5095e-01,  1.1532e+02,  8.0865e+01,  8.2493e-01]],

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grad_fn=<AddBackward0>)
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grad_fn=<AddBackward0>)
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 [ 1.1612e+02, 3.6005e+00, 6.5569e+01, 8.4366e+01, 1.2448e+00],
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 [ 9.4484e+01, 2.2361e+00, 8.0774e+01, 7.9108e+01, -7.9939e-01],
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[[ 5.8523e+01, 5.6773e+00, 9.0942e+01, 9.3976e+01, 1.0407e+00],
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...,
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[[ 1.1152e+02, 2.6773e+00, 1.0994e+02, 9.1976e+01, -7.3567e-01],

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[ 1.0348e+02,  1.2361e+00,  7.2774e+01,  8.2108e+01, -9.2898e-01],
[ 6.0464e+01,  3.6510e+00,  7.1324e+01,  9.6865e+01, -1.7043e+00]],
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 [ 7.7121e+01,  2.6005e+00,  6.1569e+01,  8.8366e+01, -3.4278e-01],
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 [ 9.3464e+01,  3.6510e+00,  9.4324e+01,  8.1865e+01, -8.6031e-01]],

[[ 1.1152e+02,  4.6773e+00,  9.8942e+01,  7.9976e+01,  2.3155e-01],
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 [ 5.9484e+01,  2.3613e-01,  1.0077e+02,  9.1108e+01, -1.0588e+00],
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[[ 1.0652e+02,  2.6773e+00,  8.3942e+01,  9.8976e+01,  3.2514e-01],
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 [ 4.0484e+01,  2.2361e+00,  1.0777e+02,  9.4108e+01, -2.8862e+00],
 [ 7.4464e+01,  6.5095e-01,  8.2324e+01,  8.9865e+01, -2.3306e+00]]],
grad_fn=<AddBackward0>)
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[[ 1.3852e+02,  4.6773e+00,  9.2942e+01,  8.7976e+01, -3.0991e+00],
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 [ 9.0121e+01,  6.0055e-01,  6.2569e+01,  9.6366e+01, -1.6897e+00],
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grad_fn=<AddBackward0>)
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[[ 9.2523e+01,  2.6773e+00,  1.1794e+02,  8.1976e+01,  5.2855e-01],
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...,

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[[ 1.1452e+02,  2.6773e+00,  7.3942e+01,  8.9976e+01,  2.3087e-01],
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 [ 6.4997e+01,  5.9037e-01,  6.9779e+01,  8.6555e+01, -2.0433e+00],
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 [ 1.2248e+02,  2.3613e-01,  8.6774e+01,  9.0108e+01, -2.5590e+00],
 [ 8.4464e+01,  3.6510e+00,  7.8324e+01,  9.8865e+01, -1.9685e+00]]],
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 [ 5.2997e+01,  2.5904e+00,  8.1779e+01,  8.2555e+01, -6.5469e-01],

```



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[ 1.2946e+02, 2.6510e+00, 1.1332e+02, 8.5865e+01, -7.8087e-01]]],
grad_fn=<AddBackward0>)
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[ 1.3520e+02, 2.9407e+00, 6.8291e+01, 8.4562e+01, -1.5493e-01],
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[ 8.6464e+01,  1.6510e+00,  9.3324e+01,  9.2865e+01,  1.6858e-02]]],
grad_fn=<AddBackward0>)
Epoch 3/5 completed
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[[ 4.3523e+01,  2.6773e+00,  7.1942e+01,  7.9976e+01,  2.3866e-02],
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 [ 1.1510e+02,  2.5757e+00,  1.0483e+02,  8.8786e+01,  6.2764e-01],
 [ 9.7484e+01,  1.2361e+00,  8.4774e+01,  8.1108e+01, -4.0019e+00],
 [ 6.3464e+01,  1.6510e+00,  8.7324e+01,  9.7865e+01, -2.5225e+00]],

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 [ 1.2200e+02,  3.5904e+00,  6.4779e+01,  8.0555e+01, -7.1962e-01],
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 [ 6.5484e+01,  1.2361e+00,  8.6774e+01,  9.3108e+01, -2.4479e+00],
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[[ 1.0652e+02,  3.6773e+00,  1.1094e+02,  8.2976e+01, -1.6569e+00],
 [ 1.1612e+02,  1.6005e+00,  6.8569e+01,  9.6366e+01,  3.0081e-01],
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[[ 6.0523e+01,  4.6773e+00,  1.0094e+02,  8.1976e+01,  2.8044e-01],
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 [ 1.0346e+02,  6.5095e-01,  8.8324e+01,  8.3865e+01,  7.1460e-01]]],
grad_fn=<AddBackward0>)
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[[ 1.0352e+02,  4.6773e+00,  9.0942e+01,  8.8976e+01, -4.7457e-02],
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[ 4.6464e+01, 6.5095e-01, 6.8324e+01, 8.0865e+01, -1.8338e-01]],

[[ 6.0523e+01, 2.6773e+00, 8.8942e+01, 8.0976e+01, 3.7190e-01],
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[ 8.2484e+01, -7.6387e-01, 1.1577e+02, 9.7108e+01, -2.0777e+00],
[ 1.3946e+02, 6.5095e-01, 8.8324e+01, 9.7865e+01, -2.3320e+00]]],
grad_fn=<AddBackward0>)
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[ 8.3997e+01, 2.5904e+00, 7.6779e+01, 8.6555e+01, -1.0277e+00],
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[ 1.1448e+02, -7.6387e-01, 7.8774e+01, 8.3108e+01, -1.9514e+00],
[ 1.1646e+02, 3.6510e+00, 6.7324e+01, 8.8865e+01, -1.0999e+00]],

[[ 1.1952e+02, 2.6773e+00, 7.1942e+01, 9.5976e+01, 3.0842e-01],
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[ 9.7484e+01,  1.2361e+00,  1.1277e+02,  8.9108e+01, -6.1069e-01],
[ 1.0146e+02,  6.5095e-01,  8.0324e+01,  8.6865e+01, -4.2312e-01]],

[[ 1.0052e+02,  4.6773e+00,  7.4942e+01,  9.3976e+01, -3.3944e-01],
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 [ 4.6484e+01,  1.2361e+00,  9.0774e+01,  9.6108e+01, -2.4296e+00],
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 [ 1.3348e+02,  1.2361e+00,  6.4774e+01,  8.3108e+01, -2.0973e+00],
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grad_fn=<AddBackward0>)
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 [ 8.3489e+01,  6.5865e-01,  1.0995e+02,  8.2111e+01, -1.6916e+00],
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 [ 5.0118e+01,  1.1776e+00,  8.0238e+01,  9.5427e+01,  1.5347e+00],

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[ 4.9656e+01, 4.2145e-01, 6.9885e+01, 9.4383e+01, 5.7799e-01],
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grad_fn=<AddBackward0>)
Epoch 4/5 completed
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[ 7.2464e+01, 6.5095e-01, 9.0324e+01, 9.0865e+01, -9.8752e-02]],

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[ 1.0812e+02, 1.6005e+00, 1.0357e+02, 9.9366e+01, -1.3786e+00],
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[ 5.7484e+01, 2.3613e-01, 8.1774e+01, 9.2108e+01, -2.6970e+00],
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[[ 6.2523e+01, 5.6773e+00, 1.0794e+02, 8.3976e+01, -1.0821e+00],
[ 9.4121e+01, 3.6005e+00, 6.6569e+01, 8.8366e+01, 7.5464e-02],
[ 9.2997e+01, 3.5904e+00, 1.1878e+02, 8.8555e+01, 6.5119e-01],

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[ 5.5484e+01, -7.6387e-01,  6.3774e+01,  9.6108e+01, -2.2284e+00],
[ 1.3746e+02,  2.6510e+00,  9.7324e+01,  8.7865e+01, -1.2925e+00]],

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[[ 8.5523e+01,  2.6773e+00,  6.8942e+01,  9.3976e+01,  1.0399e-01],
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grad_fn=<AddBackward0>)
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[[ 7.3523e+01,  5.6773e+00,  1.0894e+02,  9.7976e+01, -4.5781e-01],
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grad_fn=<AddBackward0>)
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[[ 4.5523e+01,  2.6773e+00,  7.4942e+01,  8.5976e+01, -3.8042e-01],
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 [ 4.9484e+01,  2.2361e+00,  1.1177e+02,  7.9108e+01, -7.1004e-01],
 [ 9.2464e+01,  6.5095e-01,  7.0324e+01,  8.8865e+01,  9.6427e-01]]],
grad_fn=<AddBackward0>)
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 [116.0975,  2.5757, 109.8304,  92.7863, -1.5962],
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 [ 89.4638,  2.6510, 102.3238,  91.8653,  0.3736]],
 ...,
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 [103.1214,  1.6005, 106.5694,  84.3657,  1.5911],
 [122.9975,  3.5904, 112.7787,  82.5550, -1.7928],
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 [ 88.0975, -0.4243, 105.8304,  85.7863,  2.0008],

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[[ 87.5234, 4.6773, 71.9422, 91.9759, -1.3136],
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grad_fn=<AddBackward0>)
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[ 1.3912e+02, 3.6005e+00, 1.1157e+02, 9.0366e+01, -5.1090e-01],
[ 5.6997e+01, 2.5904e+00, 1.0278e+02, 9.1555e+01, -5.4469e-03],
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[ 1.2948e+02, 2.3613e-01, 1.0277e+02, 8.2108e+01, -2.4425e+00],
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[[ 9.4523e+01, 5.6773e+00, 1.0594e+02, 9.1976e+01, -1.1306e+00],
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[ 7.1997e+01, 1.5904e+00, 1.1578e+02, 8.5555e+01, -7.1471e-02],

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[ 9.9484e+01, -7.6387e-01, 1.1777e+02, 7.9108e+01, -1.9670e+00],
[ 7.9464e+01, 2.6510e+00, 1.1032e+02, 9.1865e+01, 9.7447e-01]],

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[ 4.2464e+01, 2.6510e+00, 1.0432e+02, 8.8865e+01, -1.6525e+00]]],
grad_fn=<AddBackward0>)
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[ 1.2446e+02, 3.6510e+00, 1.1032e+02, 9.3865e+01, -7.5003e-01]],

[[ 1.2652e+02, 2.6773e+00, 1.0894e+02, 9.7976e+01, 1.2769e+00],

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[ 5.6484e+01,  2.2361e+00,  7.6774e+01,  8.5108e+01, -2.1082e+00],
[ 6.4464e+01,  1.6510e+00,  9.4324e+01,  7.9865e+01, -1.8554e+00]],

[[ 1.0052e+02,  3.6773e+00,  1.1294e+02,  9.1976e+01, -9.1214e-02],
[ 1.1412e+02,  3.6005e+00,  7.7569e+01,  9.1366e+01, -9.8631e-01],
[ 1.3500e+02,  2.5904e+00,  9.7779e+01,  7.9555e+01, -1.1687e+00],
...,
[ 7.0097e+01, -4.2427e-01,  1.1283e+02,  8.0786e+01,  1.1161e-01],
[ 1.0148e+02, -7.6387e-01,  7.3774e+01,  9.4108e+01, -3.0059e+00],
[ 5.9464e+01,  2.6510e+00,  1.1132e+02,  8.7865e+01, -8.3806e-01]],

...,

[[ 4.0523e+01,  5.6773e+00,  1.1594e+02,  9.7976e+01,  1.4075e-01],
[ 1.0112e+02,  3.6005e+00,  9.7569e+01,  9.3366e+01,  1.0451e-01],
[ 7.0997e+01,  1.5904e+00,  8.9779e+01,  8.7555e+01, -1.4215e+00],
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[ 6.5097e+01, -4.2427e-01,  6.6830e+01,  8.3786e+01,  4.3405e-01],
[ 1.1048e+02,  2.2361e+00,  1.1777e+02,  7.9108e+01, -3.1821e+00],
[ 1.1746e+02,  1.6510e+00,  1.0332e+02,  9.7865e+01, -6.8715e-01]],

[[ 1.1152e+02,  2.6773e+00,  6.5942e+01,  9.7976e+01,  4.1098e-01],
[ 1.0512e+02,  6.0055e-01,  1.0857e+02,  8.5366e+01, -1.8128e+00],
[ 4.6997e+01,  2.5904e+00,  9.7779e+01,  9.7555e+01, -1.2123e+00],
...,
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[ 4.9484e+01,  2.2361e+00,  1.0977e+02,  8.3108e+01, -2.5859e+00],
[ 7.1464e+01,  2.6510e+00,  8.8324e+01,  8.6865e+01, -1.1395e+00]],

[[ 4.8523e+01,  2.6773e+00,  1.0894e+02,  9.1976e+01,  6.7960e-01],
[ 1.0912e+02,  1.6005e+00,  1.0857e+02,  9.8366e+01,  6.4566e-02],
[ 1.2600e+02,  5.9037e-01,  1.1778e+02,  9.4555e+01, -7.9501e-01],
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[ 5.7097e+01, -4.2427e-01,  9.2830e+01,  8.9786e+01,  7.7018e-01],
[ 1.1948e+02,  1.2361e+00,  6.0774e+01,  8.3108e+01, -1.1912e+00],
[ 1.2346e+02,  6.5095e-01,  1.0632e+02,  8.3865e+01, -1.1523e+00]]],
grad_fn=<AddBackward0>)
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[ 5.7121e+01,  6.0055e-01,  8.2569e+01,  9.8366e+01, -1.2102e+00],
[ 5.7997e+01,  3.5904e+00,  6.6779e+01,  8.4555e+01, -5.8244e-01],
[ 8.5512e+01,  2.6387e+00,  7.0510e+01,  9.3027e+01, -5.1524e-01],
[ 1.0105e+02, -1.0500e+00,  8.5259e+01,  8.2309e+01,  7.4991e-01],
[ 8.3489e+01,  2.6586e+00,  1.0895e+02,  8.5111e+01,  3.9829e-01],
[ 6.0231e+01, -1.2685e-02,  6.1698e+01,  8.7186e+01,  3.8206e-01],

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[ 6.8697e+01, 1.8554e+00, 9.5694e+01, 8.5289e+01, -1.0284e-01],
[ 5.4196e+01, 1.9407e+00, 8.7291e+01, 8.6562e+01, 1.9425e+00],
[ 6.1793e+01, 9.6462e-01, 9.4186e+01, 9.7330e+01, -3.6789e-01],
[ 1.2008e+02, 8.2160e-01, 1.0614e+02, 8.8920e+01, -1.3871e+00],
[ 1.2734e+02, 3.0196e-01, 5.8407e+01, 9.1552e+01, -9.2326e-01],
[ 9.4656e+01, 2.4215e+00, 7.7885e+01, 8.7383e+01, 1.5191e-01],
[ 1.3218e+02, 4.7146e+00, 1.0466e+02, 8.6309e+01, 1.6979e+00],
[ 6.0927e+01, 2.7672e+00, 7.4202e+01, 9.0003e+01, -1.6933e+00],
[ 1.0710e+02, 2.5757e+00, 6.3830e+01, 8.0786e+01, 3.5774e-01],
[ 8.0484e+01, -7.6387e-01, 6.1774e+01, 9.8108e+01, -1.9114e+00],
[ 5.0464e+01, 3.6510e+00, 8.6324e+01, 8.7865e+01, -2.4550e+00]],

[[ 4.8523e+01, 5.6773e+00, 6.6942e+01, 9.0976e+01, -1.4155e+00],
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[ 8.7997e+01, 5.9037e-01, 7.9779e+01, 9.1555e+01, -1.6576e+00],
[ 7.2512e+01, 6.3875e-01, 8.1510e+01, 8.4027e+01, 2.1510e+00],
[ 9.4055e+01, 9.5002e-01, 9.4259e+01, 9.4309e+01, 1.4139e-01],
[ 7.5489e+01, 1.6586e+00, 6.0949e+01, 9.5111e+01, -8.1255e-01],
[ 1.1523e+02, -1.0127e+00, 6.8698e+01, 8.4186e+01, 4.2865e-01],
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[ 1.2695e+02, 9.9413e-01, 7.6911e+01, 9.2379e+01, -6.7672e-01],
[ 4.5697e+01, 3.8554e+00, 1.1669e+02, 9.5289e+01, -2.1959e+00],
[ 5.7196e+01, -5.9315e-02, 1.0529e+02, 8.1562e+01, 2.9087e-01],
[ 8.6793e+01, 1.9646e+00, 1.1519e+02, 8.2330e+01, 5.1765e-01],
[ 4.1080e+01, 2.8216e+00, 1.0314e+02, 8.0920e+01, -2.0777e-01],
[ 7.1343e+01, 1.3020e+00, 1.0541e+02, 9.1552e+01, -1.2715e+00],
[ 1.1566e+02, 2.4215e+00, 6.8885e+01, 8.3383e+01, -7.5008e-01],
[ 1.0918e+02, 4.7146e+00, 7.0664e+01, 9.0309e+01, -3.8909e-01],
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[ 6.0097e+01, 2.5757e+00, 9.6830e+01, 8.2786e+01, 5.3625e-01],
[ 1.0048e+02, -7.6387e-01, 7.2774e+01, 9.8108e+01, -3.3882e+00],
[ 6.9464e+01, 6.5095e-01, 8.7324e+01, 9.2865e+01, -1.4943e+00]],

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[ 1.1800e+02, 3.5904e+00, 1.1678e+02, 9.8555e+01, 9.2238e-02],
[ 8.7512e+01, -3.6125e-01, 9.0510e+01, 9.2027e+01, -1.5758e-01],
[ 1.1705e+02, -4.9975e-02, 8.0259e+01, 9.4309e+01, -6.8614e-01],
[ 8.1489e+01, -3.4135e-01, 1.0195e+02, 8.2111e+01, -2.2625e+00],
[ 8.1231e+01, 1.9873e+00, 8.6698e+01, 9.4186e+01, 6.4099e-01],
[ 7.4118e+01, 1.1776e+00, 6.7238e+01, 8.6427e+01, 8.6137e-02],
[ 6.3947e+01, -5.8686e-03, 8.4911e+01, 9.9379e+01, -1.8104e-01],
[ 7.3697e+01, 2.8554e+00, 8.9694e+01, 8.8289e+01, 4.1194e-01],
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[ 1.3779e+02, 2.9646e+00, 8.5186e+01, 8.3330e+01, -1.0490e+00],
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```

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[ 6.5179e+01,  5.7146e+00,  9.4664e+01,  8.3309e+01,  5.4364e-01],
[ 9.2927e+01,  1.7672e+00,  7.3202e+01,  9.2003e+01, -1.0301e+00],
[ 1.0110e+02, -4.2427e-01,  8.6830e+01,  8.1786e+01,  9.0223e-01],
[ 1.0348e+02,  1.2361e+00,  8.5774e+01,  9.1108e+01, -2.0621e+00],
[ 1.0846e+02,  6.5095e-01,  8.8324e+01,  9.3865e+01,  7.3936e-01]],

[[ 9.8523e+01,  4.6773e+00,  8.9942e+01,  9.3976e+01,  7.2060e-01],
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[ 4.5997e+01,  5.9037e-01,  7.6779e+01,  8.0555e+01, -1.0499e+00],
[ 1.1251e+02, -3.6125e-01,  1.1251e+02,  9.2027e+01,  8.1480e-01],
[ 8.3055e+01,  9.5002e-01,  7.6259e+01,  9.6309e+01,  3.6390e-01],
[ 1.1649e+02, -3.4135e-01,  1.1395e+02,  8.7111e+01, -8.4174e-01],
[ 5.4231e+01,  9.8731e-01,  1.0870e+02,  9.7186e+01,  1.8753e+00],
[ 7.7118e+01,  1.1776e+00,  9.5238e+01,  8.4427e+01,  1.1984e+00],
[ 5.2947e+01,  1.9941e+00,  7.7911e+01,  8.4379e+01, -2.2729e+00],
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[ 6.5343e+01,  3.0196e-01,  5.9407e+01,  8.6552e+01, -3.0236e+00],
[ 4.7656e+01,  4.2145e-01,  9.0885e+01,  8.1383e+01, -1.7378e+00],
[ 6.4179e+01,  2.7146e+00,  6.5664e+01,  8.2309e+01, -1.0794e+00],
[ 1.2893e+02,  1.7672e+00,  8.5202e+01,  8.2003e+01,  4.3188e-02],
[ 1.2610e+02,  1.5757e+00,  1.0383e+02,  9.8786e+01,  1.8815e-01],
[ 5.6484e+01,  2.2361e+00,  6.9774e+01,  9.1108e+01, -2.9864e+00],
[ 8.8464e+01,  3.6510e+00,  1.0032e+02,  9.4865e+01, -1.9037e+00]]],

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grad_fn=<AddBackward0>)

Epoch 5/5 completed

[]:

[]: