

# Alexnet\_Verification\_with\_Imgnet\_drop\_momentum\_training

April 19, 2024

```
[1]: import numpy as np
from functools import partial
from typing import Any, Optional

import os
import cv2
import time

import pandas as pd
import torch.nn.init as init

import torch
import torch.nn as nn
import torch.optim as optim
from torch.utils.data import Dataset, DataLoader
from PIL import Image
from torchvision import transforms
# from torch.transforms._presets import ImageClassification
# from torch.utils import _log_api_usage_once
# from ._api import register_model, Weights, WeightsEnum
# from ._meta import _IMAGENET_CATEGORIES
# from ._utils import _ovewrite_named_param, handle_legacy_interface

import matplotlib.pyplot as plt

model_alex_given = torch.hub.load('pytorch/vision:v0.10.0', 'alexnet',
    ↪pretrained=True)
model_alex_given.eval()
# Device configuration
device = torch.device('cuda' if torch.cuda.is_available() else 'cpu')
```

Using cache found in C:\Users\Limit\.cache\torch\hub\pytorch\_vision\_v0.10.0  
C:\Apps installed by Lim\anaconda3\Lib\site-packages\torchvision\models\\_utils.py:208: UserWarning: The parameter 'pretrained' is deprecated since 0.13 and may be removed in the future, please use 'weights' instead.  
warnings.warn(

C:\Apps installed by Lim\anaconda3\Lib\site-packages\torchvision\models\\_utils.py:223: UserWarning: Arguments other than a weight enum or `None` for 'weights' are deprecated since 0.13 and may be removed in the future. The current behavior is equivalent to passing `weights=AlexNet\_Weights.IMAGENET1K\_V1`. You can also use `weights=AlexNet\_Weights.DEFAULT` to get the most up-to-date weights.

```
warnings.warn(msg)
```

```
[2]: class AlexNet(nn.Module):
    def __init__(self, num_classes: int = 1000, dropout: float = 0.5) -> None:
        super().__init__()
        # _log_api_usage_once(self)
        self.features = nn.Sequential(
            nn.Conv2d(3, 96, kernel_size=11, stride=4, padding=2),
            nn.BatchNorm2d(96),
            nn.ReLU(inplace=True),
            nn.MaxPool2d(kernel_size=3, stride=2),
            nn.Conv2d(96, 256, kernel_size=5, padding=2),
            nn.BatchNorm2d(256),
            nn.ReLU(inplace=True),
            nn.MaxPool2d(kernel_size=3, stride=2),
            nn.Conv2d(256, 384, kernel_size=3, padding=1),
            nn.ReLU(inplace=True),
            nn.Conv2d(384, 384, kernel_size=3, padding=1),
            nn.ReLU(inplace=True),
            nn.Conv2d(384, 256, kernel_size=3, padding=1),
            nn.ReLU(inplace=True),
            nn.MaxPool2d(kernel_size=3, stride=2),
        )
        self.avgpool = nn.AdaptiveAvgPool2d((6, 6))
        self.classifier = nn.Sequential(
            nn.Dropout(p=dropout),
            nn.Linear(256 * 6 * 6, 4096),
            nn.ReLU(inplace=True),
            nn.Dropout(p=dropout),
            nn.Linear(4096, 4096),
            nn.ReLU(inplace=True),
            nn.Linear(4096, num_classes),
        )

    def forward(self, x: torch.Tensor) -> torch.Tensor:
        x = self.features(x)
        x = self.avgpool(x)
        x = torch.flatten(x, 1)
        x = self.classifier(x)
        return x
```

```

def initialize_weights(self):
    for m in self.modules():
        if isinstance(m, nn.Conv2d) or isinstance(m, nn.Linear):
            # Initialize weights for convolutional and linear layers
            init.xavier_uniform_(m.weight)
            if m.bias is not None:
                # Initialize biases if they exist
                init.constant_(m.bias, 0)

```

```

[3]: class ConvertToRGB(object):
    def __call__(self, img):
        if img.shape[0] == 1: # Check if the image has only one channel
            img = torch.stack([img[0]] * 3, dim=0) # Convert single channel to RGB
        return img

```

```

preprocess = transforms.Compose([
    transforms.Resize(256),
    transforms.CenterCrop(224),
    transforms.ToTensor(),
    ConvertToRGB(),
    transforms.Normalize(mean=[0.485, 0.456, 0.406], std=[0.229, 0.224, 0.225]),
])

```

```

[4]: image_path = "/Users/Limit/imagenet-object-localization-challenge_100"

```

```

filenames_image_path = []
label_train = []
root_image = []
counter = 0
current_label = 0
for root, _, filenames in os.walk(image_path):
    current_root = root
    for i in filenames:
        # print(i)
        counter += 1
        if ((counter) % 1300 == 0):
            current_label += 1
            print(counter)
            label_train.append(current_label)

# print(current_root)
# print(i)
temp = current_root + "\\ " + i
# print(temp)

```

```

        filenames_image_path.append(temp)
true_label = 0
correct_labels = 0
start_time = time.time()

counter_1=0
x_train = []
for i in range(26000):

    #     print(i)
    #     print(counter)
    image_name = filenames_image_path[i]
    # black and white
    #     image_name = "/Users/Limit/imagenet-object-localization-challenge/
    ↪n01440764/n01440764_15560.JPEG"
    input_image = Image.open(image_name)

    input_tensor = preprocess(input_image)
    #     input_batch = input_tensor.unsqueeze(0) # create a mini-batch as expected ↪
    ↪by the model
    input_batch = input_tensor
    # move the input and model to GPU for speed if available
    if torch.cuda.is_available():
        input_batch = input_batch.to('cuda')
        model_alex_given.to('cuda')
    x_train.append(input_batch)
    counter_1 += 1
    if ((counter_1+1) %1300 == 0):
        counter_1 += 1
        print(counter_1)

```

1300  
 2600  
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 5200  
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23400  
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26000

[ ]:

[5]: y\_train = label\_train[:26000]

[6]: len(x\_train)

[6]: 26000

```
[7]: # # Add channel to greyscale images so that it has 3 channels required by  
    ↪ Alexnet.  
# # Add 1 more dimension to tensor to represent channel;  
# labels = []  
  
# # Function to load images from a folder directory with multiple sub-folders  
# def load_images_from_folder(folder):  
#     images = []  
#     for root, _, filenames in os.walk(folder):  
#         for filename in filenames:  
#             # here filename has the label information  
#             label_temp = filename.rsplit('_', 1)[0]  
#             labels.append(label_temp)  
#             img = cv2.imread(os.path.join(root, filename))  
#             if img is not None:  
#                 images.append(img)  
#     return images  
  
# image_path = "/Users/Limit/imagenet-object-localization-challenge/n01440764/"  
# images = load_images_from_folder(image_path)  
  
# # Ensure grayscale images have 3 channels  
# for idx, image in enumerate(images):  
#     if len(image.shape) == 2: # If grayscale image  
#         image = cv2.cvtColor(image, cv2.COLOR_GRAY2RGB) # Convert to  
    ↪ 3-channel image  
#         images[idx] = image
```

```
# # print the number of unique labels:  
# # unique_elements = list(set(labels))  
# # print(len(unique_elements))
```

```
[8]: len(x_train)
```

```
[8]: 26000
```

```
[9]: # Define your dataset class  
class CustomDataset(Dataset):  
    def __init__(self, data, labels):  
        self.data = data  
        self.labels = labels  
  
    def __len__(self):  
        return len(self.data)  
  
    def __getitem__(self, idx):  
        return self.data[idx], torch.tensor(self.labels[idx])
```

```
[10]: # unique_labels = labels.copy()  
# unique_labels = list(set(unique_labels))  
# unique_labels.sort()  
# dict_labels = {}  
# for i in range(len(unique_labels)):  
#     dict_labels[unique_labels[i]] = i
```

```
[11]: # labels_numerical = []  
# for i in labels:  
#     labels_numerical.append(dict_labels[i])
```

```
[ ]:
```

```
[12]: # Define your loss function  
criterion = nn.CrossEntropyLoss()  
  
# Define your optimizer  
model = AlexNet().to(device)  
model.initialize_weights()  
  
optimizer = optim.Adam(model.parameters(), lr=0.005, weight_decay=5e-4)  
  
# Prepare your data  
train_data = x_train # List of input tensors  
train_labels = y_train # List of corresponding labels
```



```

dataset = CustomDataset(train_data, train_labels)
dataloader = DataLoader(dataset, batch_size=128, shuffle=True)
losses = []
grad_magnitudes = []

# Train your models
num_epochs = 45
for epoch in range(num_epochs):
    current_loss = 0.0
    for inputs, labels in dataloader:

        optimizer.zero_grad()
        outputs = model(inputs)
        Before = list(model.parameters())[0].clone()

        loss = criterion(outputs, labels)
        loss.backward()
        optimizer.step()

        current_loss += loss.item()
        After = list(model.parameters())[0].clone()

        # Log loss
        losses.append(loss.item())
        total_grad_norm = 0.0
        # Log gradient magnitudes
        for param in model.parameters():
            if param.grad is not None:
                total_grad_norm += param.grad.norm().item() ** 2
        total_grad_norm = total_grad_norm ** 0.5 # Taking the square root to
        get the norm
        grad_magnitudes.append(total_grad_norm)

    for param_group in optimizer.param_groups:
        print("Learning rate:", param_group['lr'])
    print()
    print('another way to print learning rate:')
    for group in optimizer.param_groups:
        for p in group['params']:
            print(p.grad) # Print gradients
    print('end of p.grad')
    print()
    # Verify whether gradient is computed successfully
    print(torch.equal(Before.data, After.data))
    print(f'Epoch {epoch+1} finished')
    epoch_loss = current_loss / len(dataset)

```

```
print(f'Epoch [{epoch+1}/{num_epochs}], Loss: {loss.item():.4f}')
print('*****')
print()
```

Learning rate: 0.005

another way to print learning rate:

```
tensor([[[[0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          ...,
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.]],

        [[0., 0., 0., ..., 0., 0., 0.],
         [0., 0., 0., ..., 0., 0., 0.],
         [0., 0., 0., ..., 0., 0., 0.],
         ...,
         [0., 0., 0., ..., 0., 0., 0.],
         [0., 0., 0., ..., 0., 0., 0.],
         [0., 0., 0., ..., 0., 0., 0.]],

        [[0., 0., 0., ..., 0., 0., 0.],
         [0., 0., 0., ..., 0., 0., 0.],
         [0., 0., 0., ..., 0., 0., 0.],
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         [0., 0., 0., ..., 0., 0., 0.],
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        [[0., 0., 0., ..., 0., 0., 0.],
         [0., 0., 0., ..., 0., 0., 0.],
         [0., 0., 0., ..., 0., 0., 0.],
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         [0., 0., 0., ..., 0., 0., 0.],
         [0., 0., 0., ..., 0., 0., 0.],
         [0., 0., 0., ..., 0., 0., 0.]])]
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[[0., 0., 0., ..., 0., 0., 0.],
 [0., 0., 0., ..., 0., 0., 0.],
 [0., 0., 0., ..., 0., 0., 0.],
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 [0., 0., 0., ..., 0., 0., 0.],
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 [0., 0., 0., ..., 0., 0., 0.]]],

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[[[0., 0., 0., ..., 0., 0., 0.],
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  [0., 0., 0., ..., 0., 0., 0.],
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  [0., 0., 0., ..., 0., 0., 0.]],

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[[0., 0., 0., ..., 0., 0., 0.],
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 [0., 0., 0., ..., 0., 0., 0.],
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[[0., 0., 0., ..., 0., 0., 0.],
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 [0., 0., 0., ..., 0., 0., 0.],
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[[[0., 0., 0., ..., 0., 0., 0.],
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  [0., 0., 0., ..., 0., 0., 0.],
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  [0., 0., 0., ..., 0., 0., 0.]],

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[[0., 0., 0., ..., 0., 0., 0.],
 [0., 0., 0., ..., 0., 0., 0.],
 [0., 0., 0., ..., 0., 0., 0.],

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$$\begin{aligned} & \dots, \\ & [0., 0., 0., \dots, 0., 0., 0.], \\ & [0., 0., 0., \dots, 0., 0., 0.], \\ & [0., 0., 0., \dots, 0., 0., 0.]], \end{aligned}$$
$$\begin{bmatrix} [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ \dots, \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.] \end{bmatrix}$$
$$\begin{bmatrix} [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ \vdots, \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.] \end{bmatrix},$$
$$\begin{bmatrix} 0. & 0. & 0. & \dots & 0. & 0. & 0. \\ 0. & 0. & 0. & \dots & 0. & 0. & 0. \\ 0. & 0. & 0. & \dots & 0. & 0. & 0. \\ \vdots & & & & & & \\ 0. & 0. & 0. & \dots & 0. & 0. & 0. \\ 0. & 0. & 0. & \dots & 0. & 0. & 0. \\ 0. & 0. & 0. & \dots & 0. & 0. & 0. \end{bmatrix},$$
$$\begin{bmatrix} [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ \dots, \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.]] \end{bmatrix},$$
$$\begin{bmatrix} 0. & 0. & 0. & \dots & 0. & 0. & 0. \\ 0. & 0. & 0. & \dots & 0. & 0. & 0. \\ 0. & 0. & 0. & \dots & 0. & 0. & 0. \\ \vdots & & & & & & \\ 0. & 0. & 0. & \dots & 0. & 0. & 0. \\ 0. & 0. & 0. & \dots & 0. & 0. & 0. \\ 0. & 0. & 0. & \dots & 0. & 0. & 0. \end{bmatrix},$$
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tensor([[[[0., 0., 0., 0., 0.],
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```
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[illegible]

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[illegible]

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```

end of p.grad

False

Epoch 1 finished

Epoch [1/45], Loss: 3.0670

\*\*\*\*\*

Learning rate: 0.005

another way to print learning rate:

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[illegible]



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end of p.grad

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False

Epoch 2 finished

Epoch [2/45], Loss: 2.9953

\*\*\*\*\*

Learning rate: 0.005

another way to print learning rate:

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64



[illegible]



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5.4712e-06, 5.4706e-06, 5.4812e-06, 5.5063e-06, 5.5157e-06])

```

end of p.grad

False

Epoch 3 finished

Epoch [3/45], Loss: 3.0683

\*\*\*\*\*

Learning rate: 0.005

another way to print learning rate:

```
tensor([[[[0., 0., 0., ..., 0., 0., 0.],
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          [0., 0., 0., ..., 0., 0., 0.],
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          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.]]],
       ...])
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 [0., 0., 0., ..., 0., 0., 0.],
 [0., 0., 0., ..., 0., 0., 0.],
 [0., 0., 0., ..., 0., 0., 0.]]],

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[[0., 0., 0., ..., 0., 0., 0.],
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 [0., 0., 0., ..., 0., 0., 0.],

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$$\begin{aligned} & \dots, \\ & [0., 0., 0., \dots, 0., 0., 0.], \\ & [0., 0., 0., \dots, 0., 0., 0.], \\ & [0., 0., 0., \dots, 0., 0., 0.]], \end{aligned}$$
$$\begin{bmatrix} [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ \dots, \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.]] \end{bmatrix}$$

```
[[[0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  ...,
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.]],
```

$$\begin{bmatrix} 0. & 0. & 0. & \dots & 0. & 0. & 0. \\ 0. & 0. & 0. & \dots & 0. & 0. & 0. \\ 0. & 0. & 0. & \dots & 0. & 0. & 0. \\ \vdots & & & & & & \\ 0. & 0. & 0. & \dots & 0. & 0. & 0. \\ 0. & 0. & 0. & \dots & 0. & 0. & 0. \\ 0. & 0. & 0. & \dots & 0. & 0. & 0. \end{bmatrix},$$
$$\begin{bmatrix} [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ \dots, \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.]] \end{bmatrix},$$
$$\begin{bmatrix} 0. & 0. & 0. & \dots & 0. & 0. & 0. \\ 0. & 0. & 0. & \dots & 0. & 0. & 0. \\ 0. & 0. & 0. & \dots & 0. & 0. & 0. \\ \vdots & & & & & & \\ 0. & 0. & 0. & \dots & 0. & 0. & 0. \\ 0. & 0. & 0. & \dots & 0. & 0. & 0. \\ 0. & 0. & 0. & \dots & 0. & 0. & 0. \end{bmatrix},$$
$$[[0., 0., 0., \dots, 0., 0., 0.],$$

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```

end of p.grad

False

Epoch 4 finished

Epoch [4/45], Loss: 2.9777

\*\*\*\*\*

Learning rate: 0.005

another way to print learning rate:

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[illegible]



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3.5327e-06,	3.5593e-06,	3.5402e-06,	3.5535e-06,	3.5466e-06,
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3.5355e-06,	3.5555e-06,	3.5551e-06,	3.5479e-06,	3.5377e-06,
3.5545e-06,	3.5409e-06,	3.5318e-06,	3.5409e-06,	3.5575e-06,
3.5307e-06,	3.5416e-06,	3.5304e-06,	3.5265e-06,	3.5378e-06,
3.5326e-06,	3.5406e-06,	3.5389e-06,	3.5474e-06,	3.5525e-06,
3.5526e-06,	3.5457e-06,	3.5541e-06,	3.5495e-06,	3.5541e-06,
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3.5466e-06, 3.5432e-06, 3.5498e-06, 3.5528e-06, 3.5502e-06])
end of p.grad

```

False

Epoch 5 finished

Epoch [5/45], Loss: 3.0840

\*\*\*\*\*

Learning rate: 0.005

another way to print learning rate:

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tensor([[[[0., 0., 0., ..., 0., 0., 0.],
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[illegible]



[illegible]

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$$\begin{bmatrix} 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. \end{bmatrix},$$

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[illegible]





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 4.3466e-06, 4.2509e-06, 4.2854e-06, 4.3748e-06, 4.2872e-06,  
 4.2418e-06, 4.2797e-06, 4.3349e-06, 4.2658e-06, 4.2574e-06,  
 4.3514e-06, 4.2265e-06, 4.2330e-06, 4.2706e-06, 4.2608e-06,  
 4.2907e-06, 4.3755e-06, 4.3580e-06, 4.2650e-06, 4.3114e-06,  
 4.2913e-06, 4.2751e-06, 4.3642e-06, 4.2864e-06, 4.2502e-06,  
 4.2816e-06, 4.2913e-06, 4.2565e-06, 4.3264e-06, 4.3058e-06,  
 4.3440e-06, 4.3027e-06, 4.3423e-06, 4.2564e-06, 4.2919e-06,  
 4.3974e-06, 4.3321e-06, 4.2564e-06, 4.2520e-06, 4.2215e-06,  
 4.4735e-06, 4.2243e-06, 4.3137e-06, 4.3366e-06, 4.2793e-06,



```

4.3477e-06, 4.2349e-06, 4.2304e-06, 4.2909e-06, 4.2069e-06,
4.2736e-06, 4.2451e-06, 4.2939e-06, 4.2365e-06, 4.2773e-06,
4.2536e-06, 4.3256e-06, 4.2281e-06, 4.4058e-06, 4.2765e-06,
4.2354e-06, 4.2927e-06, 4.3571e-06, 4.3170e-06, 4.3249e-06,
4.3144e-06, 4.2573e-06, 4.2244e-06, 4.3356e-06, 4.2636e-06,
4.3184e-06, 4.3370e-06, 4.2914e-06, 4.2055e-06, 4.2407e-06,
4.2457e-06, 4.2218e-06, 4.2990e-06, 4.2208e-06, 4.2898e-06,
4.3192e-06, 4.3279e-06, 4.2909e-06, 4.2072e-06, 4.2376e-06,
4.2563e-06, 4.2624e-06, 4.2295e-06, 4.3068e-06, 4.2532e-06,
4.3334e-06, 4.3154e-06, 4.3274e-06, 4.2325e-06, 4.2314e-06,
4.2408e-06, 4.3083e-06, 4.3036e-06, 4.4016e-06, 4.2672e-06,
4.2690e-06, 4.2063e-06, 4.2427e-06, 4.3058e-06, 4.2910e-06,
4.3148e-06, 4.2259e-06, 4.2505e-06, 4.2657e-06, 4.3053e-06,
4.3278e-06, 4.2286e-06, 4.2129e-06, 4.2711e-06, 4.3139e-06,
4.2757e-06, 4.2818e-06, 4.2316e-06, 4.2894e-06, 4.2222e-06,
4.3250e-06, 4.2320e-06, 4.3387e-06, 4.3728e-06, 4.2847e-06,
4.2711e-06, 4.2715e-06, 4.2538e-06, 4.3110e-06, 4.2926e-06,
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4.2264e-06, 4.2304e-06, 4.2641e-06, 4.2732e-06, 4.3624e-06,
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4.3321e-06, 4.2681e-06, 4.3038e-06, 4.3569e-06, 4.3110e-06,
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4.3872e-06, 4.3040e-06, 4.2911e-06, 4.3263e-06, 4.2368e-06,
4.2794e-06, 4.3364e-06, 4.2217e-06, 4.2722e-06, 4.3008e-06,
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4.3581e-06, 4.3470e-06, 4.2615e-06, 4.3098e-06, 4.2817e-06,
4.2500e-06, 4.3331e-06, 4.2517e-06, 4.2500e-06, 4.2584e-06,
4.2778e-06, 4.2723e-06, 4.2594e-06, 4.2298e-06, 4.2224e-06])

```

end of p.grad

False

Epoch 6 finished

Epoch [6/45], Loss: 3.0213

\*\*\*\*\*

Learning rate: 0.005

another way to print learning rate:

```
tensor([[[[0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          ...,
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.]],
        [[0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          ...,
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.]],
        [[0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          ...,
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.]]],
       ...])
```

```

[[0., 0., 0., ..., 0., 0., 0.],
 [0., 0., 0., ..., 0., 0., 0.],
 [0., 0., 0., ..., 0., 0., 0.],
 ...,
 [0., 0., 0., ..., 0., 0., 0.],
 [0., 0., 0., ..., 0., 0., 0.],
 [0., 0., 0., ..., 0., 0., 0.]]],

```

```

[[[0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  ...,
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.]],

```

```

[[0., 0., 0., ..., 0., 0., 0.],
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 ...,
 [0., 0., 0., ..., 0., 0., 0.],
 [0., 0., 0., ..., 0., 0., 0.],
 [0., 0., 0., ..., 0., 0., 0.]],

```

```

[[0., 0., 0., ..., 0., 0., 0.],
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 ...,
 [0., 0., 0., ..., 0., 0., 0.],
 [0., 0., 0., ..., 0., 0., 0.],
 [0., 0., 0., ..., 0., 0., 0.]]],

```

...,

```

[[[0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  ...,
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.]],

```

```

[[0., 0., 0., ..., 0., 0., 0.],
 [0., 0., 0., ..., 0., 0., 0.],
 [0., 0., 0., ..., 0., 0., 0.],

```

$$\begin{aligned} & \dots, \\ & [0., 0., 0., \dots, 0., 0., 0.], \\ & [0., 0., 0., \dots, 0., 0., 0.], \\ & [0., 0., 0., \dots, 0., 0., 0.]], \end{aligned}$$
$$\begin{bmatrix} [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ \dots, \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.]] \end{bmatrix}$$
$$\begin{bmatrix} [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ \vdots, \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.] \end{bmatrix},$$
$$\begin{bmatrix} 0. & 0. & 0. & \dots & 0. & 0. & 0. \\ 0. & 0. & 0. & \dots & 0. & 0. & 0. \\ 0. & 0. & 0. & \dots & 0. & 0. & 0. \\ \vdots & & & & & & \\ 0. & 0. & 0. & \dots & 0. & 0. & 0. \\ 0. & 0. & 0. & \dots & 0. & 0. & 0. \\ 0. & 0. & 0. & \dots & 0. & 0. & 0. \end{bmatrix},$$
$$\begin{bmatrix} [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ \dots, \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.]] \end{bmatrix},$$
$$\begin{bmatrix} 0. & 0. & 0. & \dots & 0. & 0. & 0. \\ 0. & 0. & 0. & \dots & 0. & 0. & 0. \\ 0. & 0. & 0. & \dots & 0. & 0. & 0. \\ \vdots & & & & & & \\ 0. & 0. & 0. & \dots & 0. & 0. & 0. \\ 0. & 0. & 0. & \dots & 0. & 0. & 0. \\ 0. & 0. & 0. & \dots & 0. & 0. & 0. \end{bmatrix},$$
$$[[0., 0., 0., \dots, 0., 0., 0.],$$

```

[0., 0., 0., ..., 0., 0., 0.],
[0., 0., 0., ..., 0., 0., 0.],
...,
[0., 0., 0., ..., 0., 0., 0.],
[0., 0., 0., ..., 0., 0., 0.],
[0., 0., 0., ..., 0., 0., 0.]],

[[[0., 0., 0., ..., 0., 0., 0.],
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[0., 0., 0., ..., 0., 0., 0.],
...,
[0., 0., 0., ..., 0., 0., 0.],
[0., 0., 0., ..., 0., 0., 0.],
[0., 0., 0., ..., 0., 0., 0.]]]])
tensor([0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
0., 0., 0., 0., 0., 0.,
0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
0., 0., 0., 0., 0., 0.,
0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
0., 0., 0., 0., 0., 0.,
0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
0., 0., 0., 0., 0., 0.])
tensor([0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
0., 0., 0., 0., 0., 0.,
0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
0., 0., 0., 0., 0., 0.,
0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
0., 0., 0., 0., 0., 0.])
tensor([[[[0., 0., 0., 0., 0.],
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[0., 0., 0., 0., 0.]],

[[[0., 0., 0., 0., 0.],
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[0., 0., 0., 0., 0.],
[0., 0., 0., 0., 0.],
[0., 0., 0., 0., 0.],

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$$\begin{aligned}
& [0., 0., 0., 0., 0.], \\
& [[0., 0., 0., 0., 0.], \\
& \quad [0., 0., 0., 0., 0.], \\
& \quad [0., 0., 0., 0., 0.], \\
& \quad [0., 0., 0., 0., 0.], \\
& \quad [0., 0., 0., 0., 0.]], \\
& \dots, \\
& [[0., 0., 0., 0., 0.], \\
& \quad [0., 0., 0., 0., 0.], \\
& \quad [0., 0., 0., 0., 0.], \\
& \quad [0., 0., 0., 0., 0.], \\
& \quad [0., 0., 0., 0., 0.]], \\
& [[0., 0., 0., 0., 0.], \\
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& \quad [0., 0., 0., 0., 0.], \\
& \quad [0., 0., 0., 0., 0.], \\
& \quad [0., 0., 0., 0., 0.]]], \\
& [[0., 0., 0., 0., 0.], \\
& \quad [0., 0., 0., 0., 0.], \\
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& \quad [0., 0., 0., 0., 0.], \\
& \quad [0., 0., 0., 0., 0.]], \\
& [[0., 0., 0., 0., 0.], \\
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& \quad [0., 0., 0., 0., 0.]], \\
& [[0., 0., 0., 0., 0.], \\
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& \quad [0., 0., 0., 0., 0.], \\
& \quad [0., 0., 0., 0., 0.], \\
& \quad [0., 0., 0., 0., 0.]], \\
& \dots,
\end{aligned}$$

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[illegible]

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          [0., 0., 0.]],

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   [0., 0., 0.]],
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   [0., 0., 0.]],

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  [0., 0., 0.]],

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  [0., 0., 0.]],

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   [0., 0., 0.]],

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  [0., 0., 0.],
  [0., 0., 0.]],

```

[illegible]

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5.1430e-06, 5.1404e-06, 5.1642e-06, 5.1901e-06, 5.2018e-06])
end of p.grad

```

False

Epoch 7 finished

Epoch [7/45], Loss: 2.9858

\*\*\*\*\*

Learning rate: 0.005

another way to print learning rate:

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5.2286e-06, 5.2320e-06, 5.2346e-06, 5.2764e-06, 5.3157e-06])
end of p.grad

```

False

Epoch 8 finished

Epoch [8/45], Loss: 2.9851

\*\*\*\*\*

Learning rate: 0.005

another way to print learning rate:

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          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.]]]])

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224



$$\begin{aligned} & [[0., 0., 0., \dots, 0., 0., 0.], \\ & [0., 0., 0., \dots, 0., 0., 0.], \\ & [0., 0., 0., \dots, 0., 0., 0.], \\ & \dots, \\ & [0., 0., 0., \dots, 0., 0., 0.], \\ & [0., 0., 0., \dots, 0., 0., 0.], \\ & [0., 0., 0., \dots, 0., 0., 0.]], \\ & [[0., 0., 0., \dots, 0., 0., 0.], \\ & [0., 0., 0., \dots, 0., 0., 0.], \\ & [0., 0., 0., \dots, 0., 0., 0.], \\ & \dots, \\ & [0., 0., 0., \dots, 0., 0., 0.], \\ & [0., 0., 0., \dots, 0., 0., 0.], \\ & [0., 0., 0., \dots, 0., 0., 0.]], \\ & [[0., 0., 0., \dots, 0., 0., 0.], \\ & [0., 0., 0., \dots, 0., 0., 0.], \\ & [0., 0., 0., \dots, 0., 0., 0.], \\ & \dots, \\ & [0., 0., 0., \dots, 0., 0., 0.], \\ & [0., 0., 0., \dots, 0., 0., 0.], \\ & [0., 0., 0., \dots, 0., 0., 0.]], \\ & [[0., 0., 0., \dots, 0., 0., 0.], \\ & [0., 0., 0., \dots, 0., 0., 0.], \\ & [0., 0., 0., \dots, 0., 0., 0.], \\ & \dots, \\ & [0., 0., 0., \dots, 0., 0., 0.], \\ & [0., 0., 0., \dots, 0., 0., 0.], \\ & [0., 0., 0., \dots, 0., 0., 0.]] \end{aligned}$$





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1.5602e-05, 1.5498e-05, 1.5417e-05, 1.6509e-05, 1.7270e-05])

```

end of p.grad

False

Epoch 9 finished

Epoch [9/45], Loss: 3.0417

\*\*\*\*\*

Learning rate: 0.005

another way to print learning rate:

```
tensor([[[[-7.7668e-22, -7.0715e-22, -5.7302e-22, ..., -1.3226e-22,
           -9.0992e-23, -1.6523e-22],
          [-6.4933e-22, -6.3436e-22, -5.2384e-22, ..., -3.3139e-23,
           -3.4078e-23, -6.0463e-23],
          [-4.4450e-22, -4.1007e-22, -3.6887e-22, ..., 1.6461e-24,
           5.5267e-23, 4.1110e-23],
          ...,
          [-5.5108e-24, -3.2177e-23, 4.7040e-23, ..., -3.2124e-22,
           -2.5599e-22, -1.6265e-22],
          [ 1.6612e-22, 1.4907e-22, 2.0291e-22, ..., 3.9643e-23,
           -5.5390e-23, -1.2812e-22],
          [ 2.0123e-22, 2.1211e-22, 2.7534e-22, ..., 1.8525e-22,
           1.6663e-22, 7.8561e-23]]],

        [[[-3.2539e-22, -2.5317e-22, -6.8511e-23, ..., 4.0437e-22,
           4.7395e-22, 3.5681e-22],
          [-2.0505e-22, -1.9207e-22, -7.4192e-23, ..., 4.6031e-22,
           4.7080e-22, 4.3936e-22],
          [ 1.3372e-23, 4.8004e-23, 1.4204e-22, ..., 5.1939e-22,
           5.6149e-22, 5.4752e-22],
          ...,
          [ 2.2850e-22, 1.8524e-22, 2.8896e-22, ..., -1.2166e-22,
           -4.0038e-23, 5.8924e-23],
          [ 3.7180e-22, 3.2981e-22, 4.0509e-22, ..., 2.0351e-22,
           1.3730e-22, 4.1825e-23],
          [ 3.9567e-22, 3.6073e-22, 4.3915e-22, ..., 3.5743e-22,
           3.2475e-22, 2.2784e-22]]],

        [[[-3.7528e-22, -3.4836e-22, -2.0678e-22, ..., 2.5189e-22,
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          [-2.9370e-22, -2.6072e-22, -9.9979e-23, ..., 2.9309e-22,
           2.9148e-22, 2.4901e-22],
          [-1.7236e-22, -9.4358e-23, 5.3474e-23, ..., 3.6307e-22,
           3.9507e-22, 3.8600e-22],
          ...,
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           -6.2804e-23, 1.2081e-24],
          [ 2.4133e-22, 2.4057e-22, 3.2551e-22, ..., 1.9883e-22,
           1.4032e-22, 3.4284e-23],
          [ 2.7583e-22, 2.9294e-22, 3.7674e-22, ..., 2.7672e-22,
           2.5751e-22, 1.5581e-22]]]]],
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8.9703e-06, 8.9819e-06, 1.0754e-05, 9.8779e-06, 8.9926e-06,
9.2518e-06, 9.9785e-06, 9.7687e-06, 1.0035e-05, 1.0115e-05,
9.1238e-06, 8.8703e-06, 9.4637e-06, 9.0717e-06, 9.8071e-06,
1.0355e-05, 1.0122e-05, 9.1952e-06, 9.6211e-06, 9.3715e-06,
9.1122e-06, 1.0005e-05, 9.1418e-06, 9.1130e-06, 9.1984e-06,
9.3434e-06, 9.2852e-06, 9.1710e-06, 8.9894e-06, 8.9048e-06])
```

end of p.grad

False

Epoch 11 finished

Epoch [11/45], Loss: 3.0001

\*\*\*\*\*

Learning rate: 0.005

another way to print learning rate:

```
tensor([[[[ 1.1106e-03,  1.4204e-03,  1.4650e-03, ...,  1.8672e-03,
            1.8836e-03,  1.7046e-03],
          [ 1.3816e-03,  1.5849e-03,  1.5582e-03, ...,  2.1313e-03,
```

```

    1.8274e-03, 1.6500e-03],
  [ 1.5627e-03, 1.6202e-03, 1.6855e-03, ..., 2.1114e-03,
    1.8032e-03, 1.6427e-03],
  ...,
  [ 1.6838e-03, 1.9295e-03, 1.9274e-03, ..., 1.7757e-03,
    1.6944e-03, 1.4222e-03],
  [ 1.5752e-03, 1.7969e-03, 1.8922e-03, ..., 1.8273e-03,
    1.5119e-03, 1.3186e-03],
  [ 1.5721e-03, 1.7091e-03, 1.9029e-03, ..., 1.7527e-03,
    1.3771e-03, 1.3558e-03]],

  [[-7.9093e-04, -4.1215e-04, -3.9359e-04, ..., -1.1767e-04,
    -5.7481e-06, -1.1918e-04],
    [-6.2783e-04, -3.0753e-04, -3.5177e-04, ..., 2.6319e-04,
    3.4856e-05, -1.4112e-04],
    [-5.4306e-04, -3.6867e-04, -2.9064e-04, ..., 3.1036e-04,
    6.1018e-06, -1.3126e-04],
    ...,
    [-4.1536e-05, 2.2544e-04, 2.2435e-04, ..., 6.9485e-05,
    -1.4734e-05, -1.8838e-04],
    [-2.4006e-04, 9.7535e-05, 2.0175e-04, ..., 1.1182e-04,
    -1.6033e-04, -2.9459e-04],
    [-1.1911e-04, 9.2948e-05, 1.9499e-04, ..., 1.9909e-04,
    -1.3661e-04, -1.6978e-04]],

  [[-3.3476e-03, -3.0684e-03, -3.1200e-03, ..., -2.9361e-03,
    -2.9005e-03, -3.0891e-03],
    [-3.1714e-03, -2.9587e-03, -3.0536e-03, ..., -2.7196e-03,
    -2.9872e-03, -3.1783e-03],
    [-2.9588e-03, -2.9618e-03, -3.0088e-03, ..., -2.7496e-03,
    -3.0951e-03, -3.2394e-03],
    ...,
    [-2.9083e-03, -2.7486e-03, -2.7910e-03, ..., -3.0999e-03,
    -3.2382e-03, -3.4500e-03],
    [-3.1036e-03, -2.8593e-03, -2.7642e-03, ..., -2.9859e-03,
    -3.3652e-03, -3.5400e-03],
    [-2.9757e-03, -2.8713e-03, -2.8021e-03, ..., -2.9054e-03,
    -3.2845e-03, -3.4110e-03]]],

  [[[ 2.4208e-04, 5.1363e-04, 5.2026e-04, ..., 1.2882e-03,
    1.2563e-03, 1.1141e-03],
    [ 3.9738e-04, 5.3399e-04, 5.8423e-04, ..., 1.2757e-03,
    1.1778e-03, 1.0996e-03],
    [ 4.7194e-04, 5.7885e-04, 7.6236e-04, ..., 1.0508e-03,
    9.3928e-04, 1.0073e-03],
    ...,
    [ 6.8981e-04, 9.2784e-04, 9.1649e-04, ..., 7.7452e-04,

```

```

      8.0745e-04, 7.4851e-04],
[ 7.4669e-04, 7.6545e-04, 8.6879e-04, ..., 8.8109e-04,
 7.7376e-04, 7.3965e-04],
[ 7.6007e-04, 6.7238e-04, 7.9471e-04, ..., 7.6992e-04,
 6.2694e-04, 7.1143e-04]],

[[-4.1450e-04, -1.2996e-04, -4.3661e-05, ..., 5.9301e-04,
 6.3692e-04, 5.5325e-04],
[-3.2238e-04, -1.2969e-04, -6.1952e-05, ..., 5.7792e-04,
 5.4247e-04, 4.9627e-04],
[-3.1602e-04, -1.4158e-04, 8.8035e-05, ..., 4.3737e-04,
 3.0628e-04, 4.0869e-04],
...,
[ 1.0024e-04, 3.3288e-04, 3.8513e-04, ..., 2.5541e-04,
 3.0520e-04, 3.0296e-04],
[ 1.7207e-04, 2.0694e-04, 3.6760e-04, ..., 3.0166e-04,
 2.3332e-04, 2.3735e-04],
[ 2.6980e-04, 1.9518e-04, 2.7084e-04, ..., 2.3498e-04,
 1.3261e-04, 2.5085e-04]],

[[-1.7692e-03, -1.5420e-03, -1.4968e-03, ..., -9.5043e-04,
 -1.0885e-03, -1.3253e-03],
[-1.6847e-03, -1.5242e-03, -1.4352e-03, ..., -9.9216e-04,
 -1.1307e-03, -1.2766e-03],
[-1.5737e-03, -1.4842e-03, -1.2799e-03, ..., -1.1762e-03,
 -1.3703e-03, -1.3506e-03],
...,
[-1.3845e-03, -1.1495e-03, -1.1179e-03, ..., -1.2855e-03,
 -1.3218e-03, -1.3701e-03],
[-1.4014e-03, -1.3445e-03, -1.1930e-03, ..., -1.2493e-03,
 -1.4133e-03, -1.4611e-03],
[-1.3458e-03, -1.4374e-03, -1.3584e-03, ..., -1.3898e-03,
 -1.5273e-03, -1.5095e-03]]],

[[[-1.7557e-03, -1.7404e-03, -1.6556e-03, ..., -1.6699e-03,
 -1.8981e-03, -1.9690e-03],
[-1.4200e-03, -1.3586e-03, -1.3313e-03, ..., -1.3598e-03,
 -1.5908e-03, -1.6204e-03],
[-1.0902e-03, -9.5878e-04, -9.3805e-04, ..., -1.1960e-03,
 -1.2312e-03, -1.3544e-03],
...,
[-1.2070e-03, -1.0621e-03, -9.8112e-04, ..., -1.5885e-03,
 -1.6655e-03, -1.7373e-03],
[-1.4071e-03, -1.2992e-03, -1.0931e-03, ..., -1.9560e-03,
 -1.9879e-03, -2.0328e-03],
[-1.5025e-03, -1.4537e-03, -1.3904e-03, ..., -2.0985e-03,
 -2.0670e-03, -2.1840e-03]],

```



```

[[-1.4283e-03, -1.3980e-03, -1.3291e-03, ..., -1.3653e-03,
  -1.6100e-03, -1.7675e-03],
 [-1.0926e-03, -9.9682e-04, -9.7958e-04, ..., -1.0579e-03,
  -1.2964e-03, -1.3993e-03],
 [-7.9504e-04, -6.6232e-04, -6.2966e-04, ..., -9.3105e-04,
  -9.8898e-04, -1.1861e-03],
 ...,
 [-9.7941e-04, -8.3630e-04, -7.6916e-04, ..., -1.3404e-03,
  -1.4855e-03, -1.6096e-03],
 [-1.1914e-03, -1.0813e-03, -8.7278e-04, ..., -1.7174e-03,
  -1.7883e-03, -1.9159e-03],
 [-1.3477e-03, -1.2810e-03, -1.2109e-03, ..., -1.9133e-03,
  -1.8934e-03, -2.0926e-03]],

[[-7.7381e-04, -7.4044e-04, -6.6324e-04, ..., -5.3782e-04,
  -7.9583e-04, -9.7930e-04],
 [-4.4365e-04, -3.1438e-04, -2.9748e-04, ..., -2.6977e-04,
  -4.9486e-04, -6.1436e-04],
 [-1.2853e-04, 1.8635e-05, 2.3484e-05, ..., -1.9968e-04,
  -2.4942e-04, -4.5283e-04],
 ...,
 [-4.5925e-04, -2.8082e-04, -1.9201e-04, ..., -6.8665e-04,
  -8.0312e-04, -9.1526e-04],
 [-6.7127e-04, -5.5111e-04, -3.6973e-04, ..., -1.0385e-03,
  -1.1225e-03, -1.2321e-03],
 [-8.0509e-04, -7.5926e-04, -7.2193e-04, ..., -1.2088e-03,
  -1.2259e-03, -1.3945e-03]]],

...,

[[[-8.6229e-04, -6.8660e-04, -4.8014e-04, ..., -4.9526e-04,
  -8.2429e-04, -8.9485e-04],
 [-6.6757e-04, -3.9860e-04, -2.9915e-04, ..., -4.9327e-04,
  -8.3753e-04, -9.2307e-04],
 [-4.2951e-04, -1.5832e-04, -2.3271e-04, ..., -6.3856e-04,
  -7.6131e-04, -6.9100e-04],
 ...,
 [ 3.0593e-04, 5.1345e-04, 4.9721e-04, ..., 2.2292e-04,
  3.8262e-05, -9.7363e-05],
 [ 1.1936e-05, 2.2647e-04, 4.7273e-04, ..., -1.1485e-04,
  -3.7216e-04, -3.8832e-04],
 [-3.1203e-04, -6.5524e-05, 2.0076e-04, ..., -6.6748e-04,
  -5.9329e-04, -6.5688e-04]],

[[-9.5871e-04, -8.4303e-04, -7.4038e-04, ..., -8.3089e-04,

```

```

-1.1370e-03, -1.2577e-03],
[-6.9756e-04, -4.7643e-04, -5.4730e-04, ..., -8.5560e-04,
-1.1111e-03, -1.2344e-03],
[-4.1872e-04, -2.4379e-04, -4.2058e-04, ..., -1.0264e-03,
-1.1432e-03, -1.0802e-03],
...,
[ 4.3549e-04,  6.4464e-04,  5.0110e-04, ...,  5.9332e-05,
-1.7944e-04, -2.6085e-04],
[ 4.6946e-05,  3.2446e-04,  5.2353e-04, ..., -2.6530e-04,
-5.1056e-04, -4.5450e-04],
[-3.2974e-04, -2.1139e-05,  2.0738e-04, ..., -7.5101e-04,
-6.5519e-04, -7.3934e-04]],

[[-8.3836e-04, -6.9175e-04, -5.8827e-04, ..., -5.9760e-04,
-9.4551e-04, -1.0860e-03],
[-7.1024e-04, -4.5478e-04, -4.6551e-04, ..., -5.7806e-04,
-9.4162e-04, -1.0493e-03],
[-4.1909e-04, -2.4964e-04, -3.6163e-04, ..., -7.3963e-04,
-8.5425e-04, -7.4235e-04],
...,
[ 2.9582e-04,  4.9983e-04,  4.3272e-04, ...,  3.3264e-04,
 1.6927e-04,  7.9111e-05],
[-2.8274e-05,  1.8700e-04,  4.1858e-04, ..., -2.2775e-05,
-2.5011e-04, -2.5698e-04],
[-3.9645e-04, -1.0810e-04,  1.6424e-04, ..., -6.3931e-04,
-5.5051e-04, -5.4221e-04]]],

[[[ 6.5601e-05, -4.8591e-04, -5.1993e-04, ..., -1.3670e-03,
-1.3006e-03, -7.9090e-04],
[-1.7884e-04, -3.7748e-04, -8.3191e-04, ..., -1.7842e-03,
-1.1893e-03, -7.9790e-04],
[-6.5592e-04, -7.6428e-04, -1.1558e-03, ..., -1.3349e-03,
-6.9158e-04, -4.2195e-04],
...,
[-7.1503e-05, -1.5184e-04, -2.2236e-04, ...,  5.0981e-04,
 5.2169e-04,  1.2618e-04],
[ 4.0912e-04,  7.9329e-04,  8.3130e-04, ...,  2.9827e-04,
 8.3762e-05,  2.3418e-04],
[ 8.7511e-04,  1.3898e-03,  1.0742e-03, ..., -1.8566e-04,
-8.1481e-05,  3.7416e-04]]],

[[-7.4193e-04, -1.2706e-03, -1.4249e-03, ..., -2.2519e-03,
-2.2270e-03, -1.7951e-03],
[-1.0313e-03, -1.4024e-03, -1.8186e-03, ..., -2.8019e-03,
-2.2311e-03, -1.7973e-03],
[-1.5136e-03, -1.8044e-03, -2.2350e-03, ..., -2.5335e-03,
-1.7324e-03, -1.3578e-03],

```

```

...,
[-1.0663e-03, -1.0052e-03, -1.1820e-03, ..., -5.4400e-04,
 -4.8746e-04, -8.9956e-04],
[-4.5957e-04, 3.7888e-05, 3.3082e-05, ..., -5.1988e-04,
 -6.7935e-04, -5.5065e-04],
[-1.0568e-04, 5.2220e-04, 3.0501e-04, ..., -1.0346e-03,
 -9.6220e-04, -5.5593e-04]],

[[ 1.2949e-03, 9.0166e-04, 6.9584e-04, ..., -1.1271e-04,
 1.8526e-04, 8.2082e-04],
 [ 1.0262e-03, 7.1702e-04, 2.2845e-04, ..., -4.9498e-04,
 2.9200e-04, 9.0689e-04],
 [ 5.2211e-04, 2.0582e-04, -2.9367e-04, ..., -1.1878e-04,
 8.0812e-04, 1.3774e-03],

...,
 [ 1.1973e-03, 1.2439e-03, 1.1016e-03, ..., 1.9283e-03,
 2.1751e-03, 1.7802e-03],
 [ 1.9425e-03, 2.3263e-03, 2.3433e-03, ..., 1.7895e-03,
 1.7102e-03, 1.9765e-03],
 [ 2.3509e-03, 2.8273e-03, 2.6395e-03, ..., 1.2835e-03,
 1.3515e-03, 2.0471e-03]]],

[[[-3.0815e-03, -3.1510e-03, -2.9908e-03, ..., -2.9882e-03,
 -2.8804e-03, -2.9325e-03],
 [-2.9069e-03, -3.0096e-03, -2.9880e-03, ..., -3.0060e-03,
 -2.8367e-03, -2.9244e-03],
 [-2.5304e-03, -2.6360e-03, -2.7396e-03, ..., -2.7311e-03,
 -2.6808e-03, -2.8186e-03],

...,
 [-6.5086e-04, -3.5904e-04, -4.1764e-08, ..., -2.4801e-04,
 -5.8340e-04, -8.1095e-04],
 [-6.3294e-04, -4.7501e-04, -1.2825e-04, ..., -1.7412e-04,
 -2.8340e-04, -6.2628e-04],
 [-7.1777e-04, -5.2804e-04, -3.3864e-04, ..., -3.9904e-04,
 -4.0888e-04, -7.5161e-04]],

[[-2.8032e-03, -2.9314e-03, -2.8972e-03, ..., -3.1112e-03,
 -3.0645e-03, -3.1697e-03],
 [-2.6450e-03, -2.7870e-03, -2.8990e-03, ..., -3.1802e-03,
 -3.0476e-03, -3.1611e-03],
 [-2.3498e-03, -2.4733e-03, -2.6797e-03, ..., -2.9664e-03,
 -2.9440e-03, -3.1353e-03],

...,
 [-6.8629e-04, -3.9106e-04, -1.2918e-04, ..., -3.1756e-04,
 -6.6463e-04, -9.7943e-04],
 [-6.4539e-04, -4.8581e-04, -2.4102e-04, ..., -2.2736e-04,
 -3.4382e-04, -8.1618e-04],

```

```

[-7.8439e-04, -6.0488e-04, -4.7083e-04, ..., -5.8047e-04,
 -6.4216e-04, -1.0361e-03]],

[[-2.6086e-03, -2.6703e-03, -2.6020e-03, ..., -2.7178e-03,
 -2.6305e-03, -2.7958e-03],
 [-2.3870e-03, -2.4376e-03, -2.4939e-03, ..., -2.7710e-03,
 -2.5757e-03, -2.7717e-03],
 [-2.1303e-03, -2.2164e-03, -2.3803e-03, ..., -2.6193e-03,
 -2.6175e-03, -2.8392e-03],
 ...,
 [-7.4842e-04, -4.3601e-04, -1.7675e-04, ..., -1.5846e-04,
 -5.1027e-04, -8.5490e-04],
 [-7.3455e-04, -5.4355e-04, -2.9907e-04, ..., -1.1071e-04,
 -2.3103e-04, -6.9581e-04],
 [-8.7786e-04, -6.8508e-04, -5.6652e-04, ..., -4.4611e-04,
 -5.2879e-04, -9.6409e-04]]])
tensor([ 1.9092e-08,  5.3551e-09, -6.4028e-10,  2.0955e-09, -9.1968e-09,
  9.3132e-09,  1.8044e-09, -4.8894e-09, -2.0023e-08,  4.6566e-09,
  2.4447e-08,  3.2014e-10,  4.1910e-08, -6.9849e-10,  1.3271e-08,
 -3.7253e-09,  4.6566e-09, -6.4028e-09,  3.3760e-09, -1.8161e-08,
  1.8044e-09, -8.6147e-09, -1.3388e-08, -4.8894e-09,  1.5134e-09,
 -5.0641e-09,  2.9802e-08, -1.0477e-08,  3.7835e-09,  3.1432e-09,
 -2.7940e-09,  3.1432e-09, -1.0186e-09, -3.1432e-09,  2.3283e-08,
  7.7998e-09, -1.2224e-09,  8.7311e-10, -1.3970e-08, -1.0012e-08,
  3.0734e-08, -5.8208e-10, -5.7917e-09,  3.4925e-09, -4.3656e-10,
  1.2224e-09,  6.8685e-09,  4.6566e-09,  1.4203e-08,  8.1491e-09,
  4.8021e-10,  1.1642e-09, -1.1350e-08,  3.8417e-09,  6.8685e-09,
 -3.7253e-09,  4.1910e-09,  2.5611e-09,  1.3271e-08,  9.8953e-09,
 -3.2014e-09, -1.7462e-09,  5.0641e-09, -3.3178e-09,  9.3132e-10,
 -6.7521e-09, -5.2387e-10, -6.6357e-09,  5.1223e-09, -1.1874e-08,
  1.2573e-08,  8.1491e-10,  6.4028e-09,  1.3970e-09, -1.3097e-09,
 -2.3283e-09,  3.2596e-09,  5.1223e-09,  2.5029e-09,  5.7626e-09,
 -3.3178e-09, -3.0268e-09, -1.1642e-09,  1.9791e-09, -1.6415e-08,
  2.3283e-10, -1.5716e-09,  4.4238e-09,  6.6939e-10,  1.6298e-08,
 -4.8894e-09,  2.3283e-09,  1.1642e-10,  7.4506e-09,  1.2107e-08,
  3.9581e-09])
tensor([ 2.1124e-03,  3.4580e-04, -1.6344e-02,  1.0449e-02, -3.3380e-03,
  3.7324e-02,  1.7078e-03, -1.7338e-02, -6.6033e-04,  1.7559e-03,
  9.5787e-03, -9.7346e-03,  8.8431e-04, -5.0017e-03,  2.0300e-02,
  6.2090e-04,  3.4892e-02,  1.1654e-02, -8.0523e-03,  3.4800e-02,
 -1.3400e-02,  4.6384e-03, -2.2113e-04,  1.6948e-02,  4.5595e-03,
 -4.2569e-03,  3.9006e-03,  3.3174e-02,  4.8846e-03,  8.8860e-03,
 -1.2752e-02,  1.0730e-02, -9.2863e-03,  4.5023e-03,  2.3034e-03,
 -2.2162e-02, -1.5764e-02, -4.9394e-03, -1.7167e-03, -3.4592e-03,
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1.1768e-07,	8.4691e-08,	1.7992e-07,	1.1085e-07,	1.4652e-07,
1.4001e-07,	1.8328e-07,	1.6970e-07,	1.2251e-07,	9.5231e-08,
1.8188e-07,	1.6474e-07,	1.1212e-07,	1.8789e-07,	1.2673e-07,
1.0032e-07,	1.1939e-07,	1.6947e-07,	1.8440e-07,	1.0650e-07,
8.5417e-08,	1.3716e-07,	1.8734e-07,	1.7782e-07,	1.4500e-07,
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1.8706e-07,	1.5748e-07,	1.8608e-07,	1.0810e-07,	1.5366e-07,
1.2223e-07,	1.5858e-07,	1.5510e-07,	1.8549e-07,	9.2603e-08,
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1.7900e-07,	1.3701e-07,	1.5993e-07,	1.2258e-07,	1.4547e-07,
1.8548e-07,	9.5173e-08,	9.8184e-08,	1.2060e-07,	1.8584e-07,
8.4726e-08,	1.4021e-07,	1.7945e-07,	1.4511e-07,	9.7920e-08,
7.0943e-08,	1.4325e-07,	1.7875e-07,	1.7089e-07,	1.4528e-07,
1.8880e-07,	1.8797e-07,	1.4234e-07,	8.1599e-08,	1.2218e-07,
1.1627e-07,	1.3274e-07,	8.6085e-08,	8.5483e-08,	1.1759e-07,
1.7710e-07,	1.1719e-07,	1.7349e-07,	1.7232e-07,	1.8744e-07,
7.1002e-08,	1.4511e-07,	9.6315e-08,	1.0402e-07,	1.7641e-07,
8.7623e-08,	1.0839e-07,	1.7119e-07,	1.8177e-07,	7.7253e-08,
1.7299e-07,	1.7231e-07,	1.1172e-07,	7.2243e-08,	1.5981e-07,
1.7645e-07,	9.5425e-08,	1.7561e-07,	1.2336e-07,	1.8329e-07,
1.6516e-07,	1.3384e-07,	7.4352e-08,	1.7436e-07,	8.7009e-08,
1.1594e-07,	1.7855e-07,	1.6493e-07,	1.5722e-07,	9.4173e-08,
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8.5183e-08,	1.8499e-07,	1.0985e-07,	1.1645e-07,	1.2090e-07,
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1.7649e-07,	1.5497e-07,	7.6873e-08,	1.1216e-07,	1.3297e-07,
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1.0492e-07,	1.8389e-07,	1.2263e-07,	1.5330e-07,	1.1744e-07,
8.4488e-08,	1.5505e-07,	1.8123e-07,	1.3026e-07,	1.6762e-07,

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1.4197e-07,	1.0607e-07,	7.6240e-08,	1.8520e-07,	8.4710e-08,
7.7143e-08,	1.8374e-07,	1.7006e-07,	1.1222e-07,	1.4439e-07,
8.0268e-08,	1.8501e-07,	1.7247e-07,	1.5984e-07,	1.3268e-07,
7.6339e-08,	1.8156e-07,	1.6881e-07,	1.5143e-07,	8.0526e-08,
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1.2513e-07,	1.2485e-07,	1.8659e-07,	1.8824e-07,	1.5983e-07,
9.5011e-08,	1.3391e-07,	1.7951e-07,	1.8699e-07,	8.2399e-08,
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1.3393e-07,	1.0626e-07,	1.5760e-07,	9.8650e-08,	1.4122e-07,
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1.8317e-07,	1.0393e-07,	9.1608e-08,	1.3236e-07,	1.8742e-07,
8.7679e-08,	9.1253e-08,	1.2401e-07,	1.3440e-07,	1.8619e-07,
1.5421e-07,	1.7531e-07,	1.7954e-07,	1.8102e-07,	1.5526e-07,
1.3916e-07,	1.7823e-07,	1.8978e-07,	1.4778e-07,	1.2838e-07,
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1.8608e-07,	1.3089e-07,	1.6770e-07,	1.8684e-07,	1.7009e-07,
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1.3895e-07,	1.8773e-07,	8.2257e-08,	1.3319e-07,	1.5763e-07,
1.8847e-07,	1.3062e-07,	1.7530e-07,	1.7720e-07,	1.0842e-07,

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1.7434e-07, 1.5263e-07, 1.5113e-07, 1.1341e-07, 1.5508e-07,
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9.1056e-08, 9.3221e-08, 1.6284e-07, 1.8419e-07, 9.4344e-08,
1.3156e-07, 1.8999e-07, 1.8072e-07, 1.8843e-07, 1.8978e-07,
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1.8611e-07, 1.9092e-07, 1.2308e-07, 1.7336e-07, 1.4605e-07,
1.1339e-07, 1.8910e-07, 1.1446e-07, 1.1154e-07, 1.2134e-07,
1.3851e-07, 1.3732e-07, 1.2158e-07, 9.1365e-08, 8.5195e-08])
end of p.grad

```

False

Epoch 12 finished

Epoch [12/45], Loss: 3.9413

\*\*\*\*\*

Learning rate: 0.005

another way to print learning rate:

```

tensor([[[[-4.6458e-30, -6.8059e-30, 1.7216e-29, ..., 4.6252e-29,
        6.0139e-29, 6.3407e-29],
  [ 9.1831e-31, 2.8973e-30, 2.8156e-29, ..., 6.2153e-29,
        7.0050e-29, 8.1655e-29],
  [ 1.5961e-29, 1.9434e-29, 2.8063e-29, ..., 5.9665e-29,
        6.9414e-29, 9.0849e-29],
  ...,
  [ 1.6341e-29, 3.4380e-29, 5.9226e-29, ..., 2.3083e-29,
        1.4794e-29, 5.2167e-30],
  [ 4.3298e-29, 6.6538e-29, 8.3831e-29, ..., 1.5056e-29,
        1.5896e-29, 7.2425e-30],
  [ 7.9433e-29, 9.7480e-29, 1.0182e-28, ..., 1.3634e-29,
        1.8017e-29, 7.0225e-30]],
  [[[-9.5991e-29, -1.0102e-28, -7.4053e-29, ..., -4.2695e-29,
        -3.1683e-29, -2.5991e-29],
  [-8.4127e-29, -8.4108e-29, -5.6573e-29, ..., -2.3500e-29,
        -1.8193e-29, -6.1578e-30],
  [-7.3030e-29, -6.6781e-29, -5.5066e-29, ..., -2.4447e-29,
        -1.6361e-29, 3.2658e-30],

```



```

...,
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 -6.7111e-29, -7.6287e-29],
[ 6.9412e-31, 1.3538e-29, 1.8481e-29, ..., -6.2613e-29,
 -6.2267e-29, -7.5385e-29]],

[[-7.6406e-29, -7.6899e-29, -4.6856e-29, ..., -2.8813e-29,
 -2.4553e-29, -2.5615e-29],
 [-6.2264e-29, -5.4454e-29, -2.1988e-29, ..., -6.3305e-30,
 -6.2714e-30, -9.7907e-31],
 [-5.0792e-29, -4.1685e-29, -2.5614e-29, ..., -9.5426e-30,
 -5.9907e-30, 8.2814e-30],

...,
[-3.3544e-29, -1.3584e-29, 1.6648e-29, ..., -2.2839e-29,
 -4.0613e-29, -5.4706e-29],
[ 9.2436e-30, 3.0312e-29, 4.8188e-29, ..., -1.7678e-29,
 -3.1931e-29, -4.5729e-29],
[ 4.3493e-29, 5.9129e-29, 6.3357e-29, ..., -2.3115e-29,
 -2.8163e-29, -4.7812e-29]]],

[[[-4.9294e-29, -3.9646e-29, -4.9724e-30, ..., 5.1976e-29,
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 [-2.8501e-29, -1.9100e-29, 2.7156e-29, ..., 7.7941e-29,
 9.1253e-29, 9.7052e-29],
 [ 2.2390e-30, 8.2757e-30, 4.1540e-29, ..., 7.9214e-29,
 9.3656e-29, 1.1616e-28],

...,
[ 6.6182e-29, 8.8038e-29, 1.1162e-28, ..., 6.3257e-29,
 6.0954e-29, 4.1712e-29],
[ 1.0635e-28, 1.1005e-28, 1.3295e-28, ..., 6.1876e-29,
 6.2265e-29, 4.7588e-29],
[ 1.4019e-28, 1.3866e-28, 1.4359e-28, ..., 6.0083e-29,
 5.3892e-29, 3.7407e-29]],

[[-1.3943e-28, -1.3515e-28, -9.7799e-29, ..., -3.8578e-29,
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 [-1.1803e-28, -1.1391e-28, -6.2148e-29, ..., -1.0644e-29,
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 [-8.8895e-29, -8.2806e-29, -4.3679e-29, ..., -9.6424e-30,
 2.2552e-30, 2.5382e-29],

...,
[-1.1119e-29, 1.4299e-29, 4.0720e-29, ..., -1.9080e-29,
 -2.6293e-29, -4.7270e-29],
[ 3.2029e-29, 3.2953e-29, 5.9451e-29, ..., -1.5237e-29,
 -2.5834e-29, -4.3150e-29],

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-3.7092e-29, -5.4309e-29]],

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-5.2361e-29, -4.6845e-29],
[-1.3834e-28, -1.2751e-28, -8.3168e-29, ..., -6.0134e-29,
-4.8405e-29, -2.2573e-29],
...,
[-5.6024e-29, -2.4976e-29, 7.2876e-30, ..., -5.2315e-29,
-5.7018e-29, -7.9669e-29],
[ 4.6213e-30, 8.1673e-30, 3.3722e-29, ..., -4.1327e-29,
-5.4911e-29, -7.5666e-29],
[ 4.2506e-29, 4.0236e-29, 4.5302e-29, ..., -4.6865e-29,
-6.5683e-29, -9.0132e-29]]],

[[[ 1.7374e-29, -6.7914e-30, -3.3600e-30, ..., 3.4331e-29,
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[ 1.6071e-29, -1.1303e-29, -2.6743e-29, ..., 7.7823e-29,
1.1075e-28, 1.0719e-28],
[ 6.5944e-30, -1.8131e-29, -1.9356e-29, ..., 9.4949e-29,
1.2325e-28, 1.3074e-28],
...,
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[-4.6949e-30, 6.9432e-30, 3.7330e-29, ..., 6.1572e-29,
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6.4335e-29, 4.5499e-29]],

[[-5.3872e-29, -7.6768e-29, -6.9508e-29, ..., -3.0722e-29,
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[-5.0043e-29, -7.7525e-29, -8.4605e-29, ..., 8.9426e-30,
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[-5.8935e-29, -7.8565e-29, -6.8053e-29, ..., 3.0189e-29,
5.0397e-29, 5.6079e-29],
...,
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-4.2148e-29, -2.7557e-29],
[-7.6419e-29, -6.8437e-29, -3.2539e-29, ..., -1.6830e-29,
-3.9970e-29, -3.3652e-29],
[-8.7047e-29, -6.9430e-29, -4.0249e-29, ..., -1.7599e-29,
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5.4180e-06,	5.4234e-06,	5.3688e-06,	5.3248e-06,	5.3315e-06,
5.3450e-06,	5.3472e-06,	5.3253e-06,	5.3987e-06,	5.3433e-06,
5.4384e-06,	5.4128e-06,	5.4391e-06,	5.3351e-06,	5.3357e-06,
5.3294e-06,	5.4079e-06,	5.4020e-06,	5.5208e-06,	5.3547e-06,
5.3512e-06,	5.3260e-06,	5.3313e-06,	5.3982e-06,	5.3773e-06,
5.4121e-06,	5.3249e-06,	5.3333e-06,	5.3520e-06,	5.4014e-06,
5.4182e-06,	5.3268e-06,	5.3299e-06,	5.3485e-06,	5.4072e-06,
5.3620e-06,	5.3660e-06,	5.3323e-06,	5.3645e-06,	5.3250e-06,
5.4101e-06,	5.3296e-06,	5.4401e-06,	5.4823e-06,	5.3663e-06,
5.3502e-06,	5.3558e-06,	5.3404e-06,	5.3974e-06,	5.3851e-06,
5.4211e-06,	5.3322e-06,	5.3335e-06,	5.3594e-06,	5.4448e-06,
5.3288e-06,	5.3284e-06,	5.3403e-06,	5.3465e-06,	5.4736e-06,
5.3845e-06,	5.4037e-06,	5.4161e-06,	5.4976e-06,	5.3810e-06,
5.3608e-06,	5.4158e-06,	5.4373e-06,	5.3728e-06,	5.3452e-06,
5.3515e-06,	5.3971e-06,	5.3666e-06,	5.4216e-06,	5.3734e-06,
5.4296e-06,	5.3469e-06,	5.4000e-06,	5.4892e-06,	5.4042e-06,
5.3480e-06,	5.3384e-06,	5.4269e-06,	5.4307e-06,	5.3900e-06,
5.5093e-06,	5.4011e-06,	5.3825e-06,	5.4290e-06,	5.3336e-06,
5.3597e-06,	5.4402e-06,	5.3306e-06,	5.3558e-06,	5.3908e-06,
5.4535e-06,	5.3610e-06,	5.4093e-06,	5.4152e-06,	5.3316e-06,
5.4155e-06,	5.3890e-06,	5.3203e-06,	5.3420e-06,	5.4141e-06,
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5.3872e-06,	5.4300e-06,	5.3476e-06,	5.3344e-06,	5.3232e-06,
5.3695e-06,	5.3412e-06,	5.3353e-06,	5.4137e-06,	5.4062e-06,
5.3560e-06,	5.3904e-06,	5.3340e-06,	5.3451e-06,	5.3448e-06,
5.3902e-06,	5.3385e-06,	5.3231e-06,	5.3376e-06,	5.3380e-06,
5.3434e-06,	5.4221e-06,	5.3381e-06,	5.4456e-06,	5.4238e-06,
5.5357e-06,	5.4688e-06,	5.3546e-06,	5.3380e-06,	5.3956e-06,
5.3242e-06,	5.4392e-06,	5.3963e-06,	5.3287e-06,	5.4184e-06,
5.3276e-06,	5.3280e-06,	5.5365e-06,	5.4349e-06,	5.3304e-06,
5.3551e-06,	5.4378e-06,	5.4154e-06,	5.4437e-06,	5.4498e-06,
5.3355e-06,	5.3281e-06,	5.3854e-06,	5.3363e-06,	5.4258e-06,
5.4701e-06,	5.4617e-06,	5.3457e-06,	5.4133e-06,	5.3725e-06,

```
5.3436e-06, 5.4430e-06, 5.3430e-06, 5.3405e-06, 5.3455e-06,
5.3623e-06, 5.3599e-06, 5.3372e-06, 5.3320e-06, 5.3347e-06])
end of p.grad
```

False

Epoch 13 finished

Epoch [13/45], Loss: 3.0715

\*\*\*\*\*

Learning rate: 0.005

another way to print learning rate:

```
tensor([[[[-8.2045e-04, -7.0759e-04, -8.8147e-04, ..., -7.5764e-04,
-8.3502e-04, -1.0887e-03],
[-6.6554e-04, -5.9924e-04, -5.9669e-04, ..., -8.1981e-04,
-8.4891e-04, -1.0743e-03],
[-5.8031e-04, -5.4370e-04, -4.0501e-04, ..., -7.5030e-04,
-7.3898e-04, -8.4000e-04],
...,
[-1.1896e-03, -9.6629e-04, -1.0182e-03, ..., -7.0342e-04,
-6.7522e-04, -6.5019e-04],
[-1.0729e-03, -1.0414e-03, -8.5872e-04, ..., -7.3730e-04,
-6.2490e-04, -6.2782e-04],
[-1.1099e-03, -1.0736e-03, -8.8618e-04, ..., -7.7650e-04,
-7.3849e-04, -7.8716e-04]],

[[-1.3162e-04, -8.4200e-05, -1.8394e-04, ..., -9.7568e-05,
-1.7625e-04, -4.6840e-04],
[ 1.2399e-05, 5.0390e-05, -2.8198e-06, ..., -9.9970e-05,
-2.0936e-04, -4.6002e-04],
[ 1.0452e-04, 1.6742e-04, 2.3037e-04, ..., 1.8733e-05,
-2.6560e-05, -2.4477e-04],
...,
[-3.9411e-04, -2.7383e-04, -3.2591e-04, ..., -1.4973e-04,
-1.0554e-04, -4.2554e-05],
[-3.3471e-04, -3.6377e-04, -2.3439e-04, ..., -1.5389e-04,
-1.7767e-06, 3.9382e-05],
[-3.5530e-04, -3.9012e-04, -2.7491e-04, ..., -1.6393e-04,
-7.3485e-05, -1.6074e-04]],

[[ 1.0124e-03, 1.0775e-03, 9.7243e-04, ..., 1.0774e-03,
9.3507e-04, 6.7370e-04],
[ 1.0521e-03, 1.0813e-03, 1.2538e-03, ..., 9.8235e-04,
8.9641e-04, 7.3762e-04],
[ 1.1375e-03, 1.2107e-03, 1.5115e-03, ..., 1.0429e-03,
9.2630e-04, 8.8266e-04],
...,
[ 5.6475e-04, 6.5845e-04, 7.2706e-04, ..., 7.0728e-04,
```

```

    7.0920e-04, 8.1557e-04],
  [ 6.6556e-04, 6.8293e-04, 9.2968e-04, ..., 7.0122e-04,
    8.0873e-04, 9.0039e-04],
  [ 5.8140e-04, 6.9751e-04, 8.9191e-04, ..., 6.6417e-04,
    7.0247e-04, 5.6251e-04]]],

[[[-5.8128e-04, -6.1021e-04, -5.7727e-04, ..., -4.5468e-04,
   -4.0476e-04, -6.9713e-04],
  [-4.3708e-04, -3.7416e-04, -4.1246e-04, ..., -4.9882e-04,
   -4.0796e-04, -6.5052e-04],
  [-3.6081e-04, -3.1247e-04, -2.2011e-04, ..., -3.4162e-04,
   -3.3738e-04, -4.6114e-04],
  ...,
  [-7.4372e-04, -4.1815e-04, -4.6138e-04, ..., -3.1093e-04,
   -3.9765e-04, -5.8245e-04],
  [-6.3350e-04, -4.9935e-04, -4.6302e-04, ..., -2.9625e-04,
   -3.0754e-04, -5.2730e-04],
  [-6.5104e-04, -5.8893e-04, -5.1336e-04, ..., -3.5950e-04,
   -3.9922e-04, -6.1341e-04]],

[[-3.4619e-04, -3.6646e-04, -3.5523e-04, ..., -2.3972e-04,
   -2.0618e-04, -5.1217e-04],
  [-1.7535e-04, -1.3196e-04, -2.4915e-04, ..., -2.4511e-04,
   -1.8677e-04, -4.5259e-04],
  [-1.0707e-04, -6.9547e-05, -2.9107e-05, ..., -9.3303e-05,
   -8.1402e-05, -2.6330e-04],
  ...,
  [-4.0857e-04, -1.8935e-04, -2.2535e-04, ..., -1.1443e-04,
   -2.5147e-04, -3.2046e-04],
  [-3.0070e-04, -2.5096e-04, -2.6051e-04, ..., -1.1043e-04,
   -1.0523e-04, -2.1974e-04],
  [-2.8213e-04, -3.0218e-04, -3.0274e-04, ..., -1.7020e-04,
   -1.2574e-04, -3.1561e-04]],

[[ 4.0435e-04, 4.1146e-04, 4.0480e-04, ..., 5.3371e-04,
   6.1811e-04, 3.7043e-04],
  [ 5.1230e-04, 5.8390e-04, 5.9709e-04, ..., 4.7250e-04,
   5.7190e-04, 4.2181e-04],
  [ 6.1677e-04, 6.6432e-04, 8.3420e-04, ..., 5.8110e-04,
   6.0308e-04, 5.6681e-04],
  ...,
  [ 2.8591e-04, 5.5022e-04, 5.6398e-04, ..., 5.2715e-04,
   3.4765e-04, 2.1940e-04],
  [ 3.6333e-04, 5.0806e-04, 5.6386e-04, ..., 5.7138e-04,
   5.0996e-04, 3.5826e-04],
  [ 3.3232e-04, 4.3627e-04, 4.7121e-04, ..., 5.1096e-04,
   4.8356e-04, 1.6748e-04]]],

```

```

[[[ 3.4673e-04,  3.6628e-04,  4.8141e-04, ...,  6.0088e-05,
    -2.4180e-05, -5.9875e-05],
 [ 4.9467e-04,  5.8321e-04,  7.8472e-04, ..., -4.3257e-05,
    1.2429e-04,  1.6057e-04],
 [ 6.7416e-04,  7.1912e-04,  7.9006e-04, ..., -1.0424e-04,
    2.3092e-04,  5.2777e-04],
 ...,
 [ 3.2374e-04,  8.0571e-05, -6.7727e-05, ...,  2.5826e-04,
    5.2534e-04,  7.3442e-04],
 [ 4.6312e-04,  9.1576e-05,  2.1811e-05, ...,  1.8356e-04,
    4.1727e-04,  8.8043e-04],
 [ 1.9231e-04,  7.0136e-05,  2.6666e-04, ...,  2.7364e-04,
    5.8393e-04,  6.9603e-04]]],

[[[ 7.0243e-04,  6.2700e-04,  8.0719e-04, ...,  4.3584e-04,
    4.4786e-04,  3.8206e-04],
 [ 8.5715e-04,  9.5548e-04,  1.1442e-03, ...,  4.3663e-04,
    4.9343e-04,  5.6506e-04],
 [ 1.1491e-03,  1.1534e-03,  1.2570e-03, ...,  4.6629e-04,
    6.6540e-04,  9.0191e-04],
 ...,
 [ 8.5917e-04,  5.5474e-04,  3.6178e-04, ...,  6.9084e-04,
    1.0008e-03,  1.0859e-03],
 [ 8.5395e-04,  5.0044e-04,  4.5681e-04, ...,  6.3619e-04,
    9.1610e-04,  1.3025e-03],
 [ 5.5657e-04,  4.8397e-04,  5.9185e-04, ...,  7.4434e-04,
    1.0475e-03,  1.0160e-03]]],

[[[ 3.2556e-03,  3.2660e-03,  3.4294e-03, ...,  2.6496e-03,
    2.7108e-03,  2.9220e-03],
 [ 3.4854e-03,  3.4380e-03,  3.7467e-03, ...,  2.5267e-03,
    2.7741e-03,  3.1408e-03],
 [ 3.7556e-03,  3.7241e-03,  3.8510e-03, ...,  2.6593e-03,
    2.9581e-03,  3.5280e-03],
 ...,
 [ 3.2773e-03,  3.1051e-03,  3.0418e-03, ...,  2.6827e-03,
    2.9346e-03,  3.2734e-03],
 [ 3.3531e-03,  3.0086e-03,  3.2298e-03, ...,  2.5470e-03,
    2.8331e-03,  3.3551e-03],
 [ 3.0128e-03,  2.9491e-03,  3.2833e-03, ...,  2.6869e-03,
    3.0535e-03,  3.1084e-03]]],

...,

```

```

[[[-1.6773e-04, 9.9333e-06, -4.3797e-05, ..., -2.6599e-06,
  1.0640e-04, 2.5602e-05],
 [-1.3807e-04, 3.6528e-05, -5.6862e-05, ..., -3.0842e-05,
  9.5439e-05, 7.8576e-05],
 [-1.7140e-04, 5.1608e-05, -6.6806e-05, ..., 2.7575e-05,
  1.5201e-04, 1.5583e-04],
 ...,
 [ 2.2515e-04, 1.3344e-04, -3.3217e-05, ..., 8.1642e-06,
 -6.3336e-05, -1.4182e-04],
 [ 2.0210e-04, 1.0805e-04, -5.7395e-06, ..., 5.7648e-05,
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 [ 5.7356e-05, 1.2752e-04, -3.2134e-05, ..., -2.9639e-06,
 6.0098e-05, -3.2802e-05]]],

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 4.3910e-04, 3.2916e-04],
 [ 2.2344e-04, 4.3943e-04, 3.0886e-04, ..., 3.2535e-04,
 4.0581e-04, 3.8473e-04],
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 4.8559e-04, 4.5706e-04],
 ...,
 [ 5.3945e-04, 4.2748e-04, 2.8160e-04, ..., 4.0394e-04,
 3.0448e-04, 1.9692e-04],
 [ 5.1164e-04, 4.4379e-04, 3.4830e-04, ..., 4.1830e-04,
 3.4292e-04, 2.5960e-04],
 [ 4.6066e-04, 5.4611e-04, 4.2160e-04, ..., 3.7739e-04,
 4.6559e-04, 4.1287e-04]]],

[[ 9.6072e-04, 1.0587e-03, 1.0229e-03, ..., 9.9102e-04,
 1.0166e-03, 9.8717e-04],
 [ 9.2757e-04, 1.0742e-03, 1.0287e-03, ..., 9.6667e-04,
 1.0424e-03, 1.0471e-03],
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 1.1434e-03, 1.1483e-03],
 ...,
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 9.4786e-04, 8.3734e-04],
 [ 1.2260e-03, 1.1040e-03, 9.7396e-04, ..., 9.6939e-04,
 9.4629e-04, 8.6035e-04],
 [ 1.1414e-03, 1.1597e-03, 9.8153e-04, ..., 9.2668e-04,
 1.0233e-03, 9.9164e-04]]],

[[[-7.0887e-04, -6.9318e-04, -6.5369e-04, ..., -1.0018e-03,
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 -1.0471e-03, -1.0726e-03],
 [-6.1241e-04, -3.5820e-04, -2.4029e-04, ..., -1.1383e-03,

```

```

-1.0184e-03, -8.9098e-04],
...,
[-1.1649e-03, -1.1222e-03, -1.1839e-03, ..., -6.7019e-04,
-7.6247e-04, -6.0603e-04],
[-1.0668e-03, -1.1262e-03, -1.0334e-03, ..., -7.3620e-04,
-8.2812e-04, -7.2089e-04],
[-1.0600e-03, -1.0007e-03, -9.0588e-04, ..., -7.9139e-04,
-7.4496e-04, -8.4810e-04]],

[[-3.2597e-04, -2.8781e-04, -2.2547e-04, ..., -5.4293e-04,
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[-1.8700e-04, -6.7441e-05, 4.9432e-05, ..., -5.9499e-04,
-5.6627e-04, -6.3948e-04],
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-5.0704e-04, -4.3553e-04],
...,
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-4.0451e-04, -3.2277e-04],
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[[ 7.2075e-04, 7.4362e-04, 8.5831e-04, ..., 3.1555e-04,
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[ 7.1435e-04, 8.8444e-04, 1.1870e-03, ..., 1.9507e-04,
2.2756e-04, 3.3150e-04],
[ 6.5447e-04, 1.0804e-03, 1.3636e-03, ..., 1.5477e-04,
2.3579e-04, 5.0385e-04],
...,
[ 1.9495e-04, 7.9559e-05, 9.0143e-05, ..., 2.2497e-04,
1.4130e-04, 2.6911e-04],
[ 2.1664e-04, 8.9777e-05, 2.6320e-04, ..., 1.7706e-04,
1.3724e-04, 2.0289e-04],
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2.0837e-04, -1.5547e-05]]],

[[[-4.4183e-04, -3.3351e-04, -3.0323e-04, ..., -6.7745e-04,
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[-4.8207e-04, -5.7802e-04, -2.9374e-04, ..., -7.9669e-04,
-7.9336e-04, -9.0748e-04],
[-5.9071e-04, -5.3395e-04, -3.1168e-04, ..., -8.9500e-04,
-7.4025e-04, -7.5485e-04],
...,
[-6.1804e-04, -7.8985e-04, -1.0525e-03, ..., -6.5901e-04,
-8.3377e-04, -6.1045e-04],
[-5.1445e-04, -7.1846e-04, -7.6453e-04, ..., -7.0959e-04,

```

```

-9.0726e-04, -7.4431e-04],
[-6.6329e-04, -7.3925e-04, -6.1436e-04, ..., -8.7671e-04,
-7.8149e-04, -6.7150e-04]],

[[ 1.5478e-04, 1.3275e-04, 2.1037e-04, ..., -1.1246e-04,
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[ 1.0924e-04, -6.7116e-05, 1.7451e-04, ..., -2.2887e-04,
-2.4569e-04, -3.9794e-04],
[ 1.8632e-05, 4.5623e-05, 2.3135e-04, ..., -2.7110e-04,
-1.6616e-04, -2.0726e-04],
...,
[ 4.8913e-05, -1.2697e-04, -4.0080e-04, ..., -5.5847e-05,
-2.0625e-04, -5.9878e-05],
[ 1.6384e-05, -1.3588e-04, -2.0058e-04, ..., -1.3626e-04,
-2.5159e-04, -1.4529e-04],
[-8.5798e-05, -2.2910e-04, -1.4164e-04, ..., -3.2731e-04,
-1.8231e-04, -1.1382e-04]],

[[ 1.9366e-03, 1.9716e-03, 2.0725e-03, ..., 1.6689e-03,
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[ 1.8496e-03, 1.6813e-03, 2.0662e-03, ..., 1.4969e-03,
1.5074e-03, 1.5114e-03],
[ 1.7033e-03, 1.7831e-03, 2.0803e-03, ..., 1.4275e-03,
1.5265e-03, 1.6290e-03],
...,
[ 1.7383e-03, 1.5085e-03, 1.3098e-03, ..., 1.3415e-03,
1.0898e-03, 1.2991e-03],
[ 1.7792e-03, 1.5636e-03, 1.6186e-03, ..., 1.2608e-03,
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 1.1076e-07, 1.1055e-07, 1.1049e-07, 1.1037e-07, 1.1070e-07,  
 1.1071e-07, 1.1050e-07, 1.1053e-07, 1.1063e-07, 1.1006e-07,  
 1.1062e-07, 1.1071e-07, 1.1025e-07, 1.1068e-07, 1.1070e-07,  
 1.1048e-07, 1.1070e-07, 1.1050e-07, 1.1019e-07, 1.1074e-07,  
 1.1050e-07, 1.1057e-07, 1.1021e-07, 1.1009e-07, 1.0919e-07,  
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 1.1052e-07, 1.0970e-07, 1.0952e-07, 1.1069e-07, 1.0885e-07,  
 1.1043e-07, 1.0993e-07, 1.1071e-07, 1.0969e-07, 1.1058e-07,  
 1.1005e-07, 1.1058e-07, 1.0951e-07, 1.1043e-07, 1.1044e-07,  
 1.0969e-07, 1.1076e-07, 1.1042e-07, 1.1066e-07, 1.1057e-07,  
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```

1.1058e-07, 1.1079e-07, 1.0901e-07, 1.1040e-07, 1.0998e-07,
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1.1055e-07, 1.1040e-07, 1.1021e-07, 1.0957e-07, 1.0937e-07])
end of p.grad

```

False

Epoch 14 finished

Epoch [14/45], Loss: 4.4818

\*\*\*\*\*

Learning rate: 0.005

another way to print learning rate:

```

tensor([[[[0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          ...,
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.]],

        [[0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          ...,
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          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.]],

        [[0., 0., 0., ..., 0., 0., 0.],
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          [0., 0., 0., ..., 0., 0., 0.],
          ...,
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.]]],

        [[[[0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          ...,
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.]]],

        [[0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          ...,
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.]]]]],

```

$$\begin{aligned} & \begin{bmatrix} [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ \vdots, \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \end{bmatrix} \\ & \vdots, \\ & \begin{bmatrix} [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ \vdots, \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \end{bmatrix} \\ & \vdots, \\ & \begin{bmatrix} [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ \vdots, \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \end{bmatrix} \end{aligned}$$

[illegible]



[illegible]

```
tensor([[[[0., 0., 0., 0., 0.],
          [0., 0., 0., 0., 0.],
          [0., 0., 0., 0., 0.],
          [0., 0., 0., 0., 0.],
          [0., 0., 0., 0., 0.]]],
```

$$\begin{bmatrix} [0., 0., 0., 0., 0.], \\ [0., 0., 0., 0., 0.], \\ [0., 0., 0., 0., 0.], \\ [0., 0., 0., 0., 0.], \\ [0., 0., 0., 0., 0.] \end{bmatrix},$$
$$\begin{bmatrix} [0., 0., 0., 0., 0.], \\ [0., 0., 0., 0., 0.], \\ [0., 0., 0., 0., 0.], \\ [0., 0., 0., 0., 0.], \\ [0., 0., 0., 0., 0.] \end{bmatrix},$$

...

$$\begin{bmatrix} [0., 0., 0., 0., 0.], \\ [0., 0., 0., 0., 0.], \\ [0., 0., 0., 0., 0.], \\ [0., 0., 0., 0., 0.], \\ [0., 0., 0., 0., 0.] \end{bmatrix},$$
$$\begin{bmatrix} 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. \end{bmatrix},$$
$$\begin{bmatrix} [0., 0., 0., 0., 0.], \\ [0., 0., 0., 0., 0.], \\ [0., 0., 0., 0., 0.], \\ [0., 0., 0., 0., 0.], \\ [0., 0., 0., 0., 0.] \end{bmatrix},$$
$$\begin{bmatrix} 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. \\ 0. & 0. & 0. & 0. & 0. \end{bmatrix},$$

```
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 [0., 0., 0., 0., 0.]],
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[[0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
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[illegible]

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          [0., 0., 0.]],

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          [0., 0., 0.]],

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          [0., 0., 0.]],

        ...,

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          [0., 0., 0.]],

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          [0., 0., 0.]],

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          [0., 0., 0.],
          [0., 0., 0.]]],

```

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 [0., 0., 0.]],

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 [0., 0., 0.]],

...,

[[0., 0., 0.],
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 4.3080e-06, 4.3152e-06, 4.3444e-06, 4.2787e-06, 4.2914e-06,  
 4.2789e-06, 4.2820e-06, 4.3122e-06, 4.2842e-06, 4.3299e-06,  
 4.3056e-06, 4.3127e-06, 4.3211e-06, 4.3703e-06, 4.2786e-06,  
 4.2770e-06, 4.2809e-06, 4.2905e-06, 4.2890e-06, 4.2848e-06,  
 4.3048e-06, 4.3042e-06, 4.3202e-06, 4.2797e-06, 4.3180e-06,  
 4.3215e-06, 4.3223e-06, 4.2857e-06, 4.2826e-06, 4.3591e-06,  
 4.2794e-06, 4.2932e-06, 4.3011e-06, 4.3663e-06, 4.2854e-06,  
 4.2826e-06, 4.2946e-06, 4.3221e-06, 4.2781e-06, 4.2817e-06,  
 4.4551e-06, 4.2844e-06, 4.2802e-06, 4.2925e-06, 4.2803e-06,  
 4.3233e-06, 4.2815e-06, 4.2833e-06, 4.3623e-06, 4.2899e-06,  
 4.2810e-06, 4.2848e-06, 4.3110e-06, 4.3129e-06, 4.2853e-06,  
 4.3711e-06, 4.2863e-06, 4.2846e-06, 4.3085e-06, 4.3053e-06,  
 4.2815e-06, 4.3176e-06, 4.3405e-06, 4.2757e-06, 4.2830e-06,  
 4.3409e-06, 4.2842e-06, 4.2997e-06, 4.2918e-06, 4.2909e-06,  
 4.2943e-06, 4.2845e-06, 4.3307e-06, 4.2915e-06, 4.3046e-06,  
 4.3174e-06, 4.3328e-06, 4.3149e-06, 4.4138e-06, 4.2877e-06,  
 4.2811e-06, 4.3093e-06, 4.3595e-06, 4.2939e-06, 4.3429e-06,  
 4.3703e-06, 4.2776e-06, 4.2749e-06, 4.2948e-06, 4.2843e-06,  
 4.3134e-06, 4.3004e-06, 4.3404e-06, 4.3052e-06, 4.2807e-06,  
 4.2826e-06, 4.3031e-06, 4.2830e-06, 4.3414e-06, 4.3782e-06,  
 4.2799e-06, 4.2925e-06, 4.2918e-06, 4.2983e-06, 4.2920e-06,  
 4.2790e-06, 4.2825e-06, 4.3557e-06, 4.2784e-06, 4.2913e-06,  
 4.2806e-06, 4.2983e-06, 4.3326e-06, 4.4302e-06, 4.3064e-06,  
 4.2932e-06, 4.3020e-06, 4.2971e-06, 4.3319e-06, 4.3044e-06,  
 4.3745e-06, 4.3401e-06, 4.2787e-06, 4.2853e-06, 4.2821e-06,  
 4.3181e-06, 4.3141e-06, 4.2868e-06, 4.3135e-06, 4.2958e-06,  
 4.3164e-06, 4.3193e-06, 4.3727e-06, 4.3074e-06, 4.3161e-06,  
 4.2768e-06, 4.3212e-06, 4.2976e-06, 4.3247e-06, 4.3343e-06,  
 4.2913e-06, 4.3475e-06, 4.2796e-06, 4.3012e-06, 4.3050e-06,  
 4.3588e-06, 4.3444e-06, 4.2855e-06, 4.2905e-06, 4.2777e-06,  
 4.2908e-06, 4.3221e-06, 4.2907e-06, 4.2914e-06, 4.2843e-06,

```
4.2812e-06, 4.2792e-06, 4.2895e-06, 4.3178e-06, 4.3314e-06])
end of p.grad
```

```
False
```

```
Epoch 15 finished
```

```
Epoch [15/45], Loss: 3.0107
```

```
*****
```

```
Learning rate: 0.005
```

```
another way to print learning rate:
```

```
tensor([[[[ 3.1282e-02,  3.1977e-02,  3.2330e-02, ...,  3.3760e-02,
            3.5168e-02,  3.6223e-02],
          [ 2.5201e-02,  2.5439e-02,  2.5770e-02, ...,  2.7056e-02,
            2.9529e-02,  3.2329e-02],
          [ 2.6351e-02,  2.5587e-02,  2.5913e-02, ...,  2.7504e-02,
            2.8331e-02,  2.9819e-02],
          ...,
          [ 3.8144e-02,  3.6826e-02,  3.4936e-02, ...,  3.5893e-02,
            3.6604e-02,  3.6844e-02],
          [ 4.0281e-02,  4.0705e-02,  4.0090e-02, ...,  3.6583e-02,
            3.6930e-02,  3.7494e-02],
          [ 3.6467e-02,  3.6228e-02,  3.6943e-02, ...,  3.4620e-02,
            3.4019e-02,  3.4820e-02]],

        [[ 6.2858e-03,  6.9655e-03,  6.6641e-03, ...,  7.5800e-03,
            8.4945e-03,  9.3905e-03],
          [ 5.3292e-04,  2.3264e-04,  7.6422e-05, ...,  1.5837e-03,
            3.1488e-03,  4.8714e-03],
          [ 3.2288e-03,  1.8254e-03,  2.1387e-03, ...,  2.5656e-03,
            3.1944e-03,  3.9272e-03],
          ...,
          [ 1.2220e-02,  1.0281e-02,  7.8475e-03, ...,  7.4777e-03,
            9.5382e-03,  1.0097e-02],
          [ 1.5161e-02,  1.4335e-02,  1.2636e-02, ...,  8.1122e-03,
            9.4231e-03,  1.0148e-02],
          [ 1.2282e-02,  1.1810e-02,  1.2019e-02, ...,  6.5879e-03,
            6.6145e-03,  7.7533e-03]],

        [[-1.6724e-02, -1.6925e-02, -1.6472e-02, ..., -1.6977e-02,
            -1.6772e-02, -1.6850e-02],
          [-1.7970e-02, -1.9307e-02, -1.8796e-02, ..., -1.8209e-02,
            -1.8201e-02, -1.8415e-02],
          [-1.5419e-02, -1.6556e-02, -1.6489e-02, ..., -1.6816e-02,
            -1.6759e-02, -1.7539e-02],
          ...,
          [-9.4353e-03, -1.0453e-02, -1.1520e-02, ..., -1.3437e-02,
            -1.2620e-02, -1.2622e-02],
```

```

[-9.0983e-03, -9.8264e-03, -1.0688e-02, ..., -1.3967e-02,
 -1.4130e-02, -1.3862e-02],
[-1.0551e-02, -1.0964e-02, -1.0703e-02, ..., -1.4862e-02,
 -1.5775e-02, -1.6160e-02]]],

[[[-3.4242e-03, -3.5112e-03, -3.5035e-03, ..., -4.1860e-03,
 -4.1916e-03, -4.2838e-03],
 [-2.7372e-03, -2.5735e-03, -2.7485e-03, ..., -3.9347e-03,
 -4.0311e-03, -4.2665e-03],
 [-3.6177e-03, -3.4508e-03, -3.5367e-03, ..., -4.5173e-03,
 -4.7613e-03, -5.1317e-03],
 ...,
 [-3.8666e-03, -3.5268e-03, -3.4104e-03, ..., -3.8899e-03,
 -3.8580e-03, -3.9653e-03],
 [-4.6161e-03, -4.2245e-03, -4.1494e-03, ..., -4.1589e-03,
 -3.9133e-03, -3.8091e-03],
 [-4.3694e-03, -4.3536e-03, -4.4595e-03, ..., -4.5687e-03,
 -4.5493e-03, -4.7014e-03]]],

[[[-4.1608e-04, -4.8552e-04, -4.7053e-04, ..., -1.0326e-03,
 -7.6151e-04, -5.4358e-04],
 [ 2.8696e-04,  2.0420e-04, -7.0800e-05, ..., -9.1228e-04,
 -1.0527e-03, -9.6581e-04],
 [-8.8626e-04, -9.5472e-04, -1.0826e-03, ..., -1.4704e-03,
 -1.6429e-03, -1.6591e-03],
 ...,
 [-5.0393e-04, -1.5861e-04,  3.5124e-05, ..., -7.9671e-04,
 -5.7722e-04, -4.0248e-04],
 [-1.1151e-03, -7.7531e-04, -5.7265e-04, ..., -8.1963e-04,
 -5.9023e-04, -4.8209e-04],
 [-1.0622e-03, -9.5682e-04, -9.6174e-04, ..., -1.3847e-03,
 -1.4885e-03, -1.4252e-03]]],

[[[-2.7202e-03, -2.8753e-03, -2.9600e-03, ..., -2.7943e-03,
 -2.7671e-03, -2.5082e-03],
 [-2.4109e-03, -2.4962e-03, -2.8216e-03, ..., -2.8767e-03,
 -2.9917e-03, -2.8497e-03],
 [-3.3035e-03, -3.3916e-03, -3.4561e-03, ..., -3.3307e-03,
 -3.3281e-03, -3.0344e-03],
 ...,
 [-2.7874e-03, -2.5689e-03, -2.5766e-03, ..., -2.9569e-03,
 -2.8666e-03, -2.5784e-03],
 [-2.8196e-03, -2.5663e-03, -2.6989e-03, ..., -2.8692e-03,
 -2.8619e-03, -2.7237e-03],
 [-2.7493e-03, -2.6755e-03, -2.8226e-03, ..., -3.0735e-03,
 -3.1516e-03, -3.0573e-03]]],

```

```

[[[ 2.4585e-02, 2.5955e-02, 2.7110e-02, ..., 3.1684e-02,
    3.3712e-02, 3.4223e-02],
 [ 1.7358e-02, 1.6899e-02, 1.7192e-02, ..., 1.7375e-02,
    1.9468e-02, 2.4250e-02],
 [ 2.0242e-02, 1.8140e-02, 1.7447e-02, ..., 1.6508e-02,
    1.7096e-02, 2.0313e-02],
 ...,
 [ 3.6209e-02, 3.3102e-02, 3.0654e-02, ..., 3.3794e-02,
    3.3512e-02, 3.3828e-02],
 [ 3.9181e-02, 3.9372e-02, 3.9428e-02, ..., 3.9486e-02,
    3.9673e-02, 4.0821e-02],
 [ 3.5492e-02, 3.5926e-02, 3.7991e-02, ..., 3.7347e-02,
    3.6808e-02, 3.9225e-02]]],

[[-9.9020e-03, -9.3410e-03, -9.3281e-03, ..., -4.6375e-03,
 -2.9234e-03, -2.4482e-03],
 [-1.5486e-02, -1.6382e-02, -1.7035e-02, ..., -1.6667e-02,
 -1.5132e-02, -1.2503e-02],
 [-1.3366e-02, -1.6296e-02, -1.6935e-02, ..., -1.7476e-02,
 -1.6713e-02, -1.4565e-02],
 ...,
 [ 8.9105e-04, -3.5951e-03, -6.4946e-03, ..., -3.9007e-03,
 -3.2830e-03, -3.8161e-03],
 [ 5.8388e-03, 4.8635e-03, 3.5844e-03, ..., 1.6803e-03,
 3.0176e-03, 4.4269e-03],
 [ 2.4276e-03, 2.3842e-03, 3.5396e-03, ..., 1.9516e-03,
 1.7331e-03, 4.2353e-03]]],

[[-4.3446e-02, -4.3890e-02, -4.3260e-02, ..., -4.1965e-02,
 -4.1166e-02, -4.0478e-02],
 [-4.3587e-02, -4.5421e-02, -4.5273e-02, ..., -4.5380e-02,
 -4.5549e-02, -4.4492e-02],
 [-4.2624e-02, -4.4898e-02, -4.5551e-02, ..., -4.4974e-02,
 -4.4920e-02, -4.5136e-02],
 ...,
 [-3.1933e-02, -3.4384e-02, -3.5904e-02, ..., -3.5380e-02,
 -3.5448e-02, -3.5212e-02],
 [-3.0816e-02, -3.1209e-02, -3.1855e-02, ..., -3.2583e-02,
 -3.3328e-02, -3.2281e-02],
 [-3.3262e-02, -3.3321e-02, -3.2323e-02, ..., -3.2353e-02,
 -3.3526e-02, -3.2981e-02]]],

...,

[[[ 1.1334e-03, -4.5238e-04, -1.3583e-03, ..., -1.9371e-03,

```



```

-3.3420e-03, -4.1280e-03],
[ 7.1031e-03,  7.5028e-03,  7.2948e-03, ...,  9.2082e-03,
 6.8311e-03,  3.0243e-03],
[ 5.0962e-03,  7.8747e-03,  9.3590e-03, ...,  1.1288e-02,
 1.0740e-02,  7.8962e-03],
...,
[-9.2518e-03, -7.3218e-03, -5.3719e-03, ..., -6.9796e-03,
-7.2405e-03, -7.6184e-03],
[-1.0509e-02, -1.0638e-02, -1.0078e-02, ..., -9.6254e-03,
-1.1005e-02, -1.2182e-02],
[-4.8302e-03, -5.0899e-03, -6.8565e-03, ..., -6.9236e-03,
-6.9061e-03, -8.6222e-03]],

[[-3.8070e-03, -5.2087e-03, -5.8334e-03, ..., -5.3677e-03,
-6.7989e-03, -7.5756e-03],
[ 2.1196e-03,  2.6322e-03,  2.7605e-03, ...,  4.4898e-03,
 2.7347e-03,  1.8282e-04],
[ 6.2170e-04,  3.6805e-03,  4.2971e-03, ...,  5.4311e-03,
 4.8907e-03,  3.1101e-03],
...,
[-1.2619e-02, -1.0227e-02, -7.9861e-03, ..., -7.5788e-03,
-8.8848e-03, -8.8012e-03],
[-1.4920e-02, -1.4475e-02, -1.3124e-02, ..., -9.8771e-03,
-1.1266e-02, -1.2283e-02],
[-8.8032e-03, -8.7793e-03, -9.9901e-03, ..., -7.6932e-03,
-7.2447e-03, -8.8343e-03]],

[[ 2.4502e-03,  2.2536e-03,  7.8889e-04, ...,  3.2160e-03,
 2.6871e-03,  1.9067e-03],
[ 3.1277e-03,  4.4214e-03,  3.9524e-03, ...,  5.4483e-03,
 5.8500e-03,  5.2787e-03],
[ 1.9130e-03,  3.9469e-03,  4.0431e-03, ...,  4.6527e-03,
 4.9453e-03,  5.6067e-03],
...,
[-6.7875e-03, -5.3948e-03, -4.2872e-03, ..., -2.9818e-03,
-3.3236e-03, -3.5637e-03],
[-5.9782e-03, -5.3488e-03, -4.8431e-03, ..., -3.1676e-03,
-2.6930e-03, -3.3543e-03],
[-1.6571e-03, -1.8701e-03, -3.3645e-03, ..., -2.1413e-03,
-7.2083e-04, -7.2130e-04]]],

[[[-1.2444e-03, -1.1969e-03, -9.8311e-04, ..., -1.4227e-03,
-1.6440e-03, -1.9475e-03],
[-1.9691e-03, -1.3879e-03, -9.2855e-04, ..., -1.0735e-03,
-1.1695e-03, -1.2310e-03],
[-2.9797e-03, -3.0466e-03, -2.7075e-03, ..., -2.2964e-03,
-2.1688e-03, -1.6970e-03],

```

```

...,
[-3.8762e-03, -2.9883e-03, -2.2016e-03, ..., -1.6298e-03,
 -1.6509e-03, -1.7648e-03],
[-5.0176e-03, -4.4967e-03, -3.8554e-03, ..., -4.6010e-03,
 -4.6864e-03, -4.6560e-03],
[-5.9862e-03, -6.1477e-03, -5.5822e-03, ..., -5.9016e-03,
 -6.0902e-03, -6.4656e-03]],

[[-4.7316e-04, -3.1623e-04, 2.1991e-05, ..., -8.1879e-04,
 -9.0198e-04, -1.1849e-03],
 [-9.7369e-04, -5.2313e-04, -2.1026e-05, ..., -3.8260e-04,
 -6.2366e-04, -7.4343e-04],
 [-2.0552e-03, -2.0922e-03, -1.7564e-03, ..., -1.1339e-03,
 -9.3841e-04, -5.9724e-04],
 ...,
 [-2.5431e-03, -1.5525e-03, -4.1465e-04, ..., -1.0556e-04,
 -2.7168e-04, -3.5320e-04],
 [-3.4304e-03, -2.8044e-03, -2.0872e-03, ..., -2.5758e-03,
 -2.4794e-03, -2.5347e-03],
 [-3.9727e-03, -4.2555e-03, -3.9428e-03, ..., -3.7032e-03,
 -3.6300e-03, -3.8035e-03]],

[[-4.8744e-03, -4.7498e-03, -4.4330e-03, ..., -4.9977e-03,
 -4.9123e-03, -4.9352e-03],
 [-5.0747e-03, -4.8695e-03, -4.8322e-03, ..., -5.0259e-03,
 -4.9628e-03, -4.6822e-03],
 [-5.5361e-03, -5.4653e-03, -5.1872e-03, ..., -5.1396e-03,
 -4.8721e-03, -4.1987e-03],
 ...,
 [-5.2299e-03, -4.7393e-03, -4.1844e-03, ..., -3.9444e-03,
 -3.9799e-03, -3.7692e-03],
 [-5.3822e-03, -5.2687e-03, -5.0183e-03, ..., -4.9680e-03,
 -4.8368e-03, -4.6746e-03],
 [-5.3111e-03, -5.4932e-03, -5.5602e-03, ..., -5.3427e-03,
 -4.9100e-03, -4.8119e-03]]],

[[[ 3.5533e-02, 3.6378e-02, 3.7204e-02, ..., 4.4413e-02,
 4.6191e-02, 4.6694e-02],
 [ 2.3890e-02, 2.2625e-02, 2.2771e-02, ..., 3.0970e-02,
 3.5750e-02, 4.1735e-02],
 [ 3.1144e-02, 2.9160e-02, 2.9257e-02, ..., 3.0117e-02,
 3.1452e-02, 3.4707e-02],
 ...,
 [ 5.1259e-02, 4.7638e-02, 4.3433e-02, ..., 4.0055e-02,
 4.1350e-02, 4.2457e-02],
 [ 5.3197e-02, 5.3556e-02, 5.1802e-02, ..., 4.6105e-02,
 4.7272e-02, 4.8696e-02],

```

```

[ 4.7044e-02,  4.6544e-02,  4.7564e-02, ...,  4.4568e-02,
 4.4305e-02,  4.5924e-02]],

[[-9.8876e-04, -4.1907e-04, -3.1263e-04, ...,  7.7189e-03,
 8.8083e-03,  8.6766e-03],
 [-1.0850e-02, -1.2097e-02, -1.2592e-02, ..., -5.2293e-03,
 -1.9650e-03,  1.8171e-03],
 [-2.5612e-03, -4.9173e-03, -4.8366e-03, ..., -3.8682e-03,
 -3.7804e-03, -2.2103e-03],
 ...,
 [ 1.4123e-02,  9.3025e-03,  4.3642e-03, ..., -1.2919e-03,
 2.2874e-03,  3.9342e-03],
 [ 1.6635e-02,  1.5820e-02,  1.3094e-02, ...,  3.4819e-03,
 6.2996e-03,  8.8339e-03],
 [ 1.2309e-02,  1.1431e-02,  1.1872e-02, ...,  4.0122e-03,
 4.0203e-03,  6.3993e-03]],

[[-3.9573e-02, -3.9560e-02, -3.8794e-02, ..., -3.5810e-02,
 -3.4985e-02, -3.4737e-02],
 [-4.0256e-02, -4.1731e-02, -4.1337e-02, ..., -3.8870e-02,
 -3.8625e-02, -3.8212e-02],
 [-3.5743e-02, -3.7338e-02, -3.7064e-02, ..., -3.5922e-02,
 -3.6510e-02, -3.7953e-02],
 ...,
 [-2.4448e-02, -2.6989e-02, -2.9100e-02, ..., -3.4570e-02,
 -3.2929e-02, -3.2496e-02],
 [-2.4924e-02, -2.5853e-02, -2.7120e-02, ..., -3.2243e-02,
 -3.2527e-02, -3.1544e-02],
 [-2.6619e-02, -2.7139e-02, -2.6332e-02, ..., -3.2375e-02,
 -3.3766e-02, -3.4079e-02]]])
tensor([-2.4214e-08,  5.8208e-10, -1.8626e-08,  4.0978e-08, -4.4703e-08,
 -2.7008e-08,  1.4901e-08, -1.4203e-08, -1.8626e-08, -3.7253e-09,
 -4.9360e-08,  7.8231e-08, -4.8429e-08,  2.3283e-09,  3.0734e-08,
 1.6764e-08, -5.7742e-08, -1.8626e-08,  3.4459e-08, -1.7229e-08,
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 [-7.7172e-03, -7.9303e-03, -8.3356e-03, -8.7428e-03, -9.2223e-03],
 [-7.6582e-03, -7.7771e-03, -7.8886e-03, -8.0743e-03, -8.4716e-03],
 [-7.7423e-03, -7.8169e-03, -7.6155e-03, -7.4520e-03, -7.7281e-03]]],
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 [-7.0516e-03, -8.5797e-03, -7.1888e-03, -4.0580e-03, -2.1362e-03],
 [-6.6199e-03, -7.7496e-03, -6.7112e-03, -4.5933e-03, -3.8974e-03],
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...,

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 [-1.5152e-02, -1.6678e-02, -1.5988e-02, -1.3704e-02, -1.2367e-02],
 [-1.4949e-02, -1.5914e-02, -1.5182e-02, -1.3215e-02, -1.2590e-02],
 [-1.5120e-02, -1.4999e-02, -1.4420e-02, -1.3853e-02, -1.4068e-02]]],
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 [-8.4299e-03, -6.5443e-03, -8.2043e-03, -9.9479e-03, -1.1656e-02],
 [-7.2941e-03, -6.9247e-03, -7.4866e-03, -8.6409e-03, -1.0026e-02],
 [-7.4076e-03, -7.4751e-03, -7.7898e-03, -7.7439e-03, -8.3034e-03]]],
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[[-2.2746e-03, -2.2158e-03, -2.0419e-03, -2.3928e-03, -2.1987e-03],
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[[-3.1310e-03, -2.9588e-03, -2.9371e-03, -3.5899e-03, -3.5092e-03],
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[[ 6.0010e-05,  5.9373e-05,  2.3276e-05,  2.7619e-06, -5.2382e-07],

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end of p.grad

```

False

Epoch 16 finished

Epoch [16/45], Loss: 20.1187

\*\*\*\*\*

Learning rate: 0.005

another way to print learning rate:

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[illegible]

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3.4885e-06, 3.4893e-06, 3.4900e-06, 3.4969e-06, 3.5016e-06])

```

end of p.grad

False

Epoch 17 finished

Epoch [17/45], Loss: 2.9766

\*\*\*\*\*

Learning rate: 0.005

another way to print learning rate:

```

tensor([[[[0., 0., 0., ..., 0., 0., 0.],
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          [0., 0., 0., ..., 0., 0., 0.],
          ...,
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.]]]])

```

$$\begin{bmatrix} [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ \vdots, \\ [0., 0., 0., \dots, 0., 0., 0.], \end{bmatrix}$$

```
[0., 0., 0., ..., 0., 0., 0.],
[0., 0., 0., ..., 0., 0., 0.]]],
```

```
...,
```

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1.9739e-06, 1.9738e-06, 1.9739e-06, 1.9736e-06, 1.9738e-06,

```

1.9736e-06, 1.9739e-06, 1.9736e-06, 1.9735e-06, 1.9731e-06,
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1.9738e-06, 1.9738e-06, 1.9736e-06, 1.9738e-06, 1.9737e-06,
1.9735e-06, 1.9739e-06, 1.9735e-06, 1.9735e-06, 1.9736e-06,
1.9737e-06, 1.9737e-06, 1.9736e-06, 1.9733e-06, 1.9731e-06])

```

end of p.grad

\*\*\*\*\*

Learning rate: 0.005

another way to print learning rate:

```
tensor([[[[0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          ...,
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.]],

        [[0., 0., 0., ..., 0., 0., 0.],
         [0., 0., 0., ..., 0., 0., 0.],
         [0., 0., 0., ..., 0., 0., 0.],
         ...,
         [0., 0., 0., ..., 0., 0., 0.],
         [0., 0., 0., ..., 0., 0., 0.],
         [0., 0., 0., ..., 0., 0., 0.]],

        [[0., 0., 0., ..., 0., 0., 0.],
         [0., 0., 0., ..., 0., 0., 0.],
         [0., 0., 0., ..., 0., 0., 0.],
         ...,
         [0., 0., 0., ..., 0., 0., 0.],
         [0., 0., 0., ..., 0., 0., 0.],
         [0., 0., 0., ..., 0., 0., 0.]],

        [[0., 0., 0., ..., 0., 0., 0.],
         [0., 0., 0., ..., 0., 0., 0.],
         [0., 0., 0., ..., 0., 0., 0.],
         ...,
         [0., 0., 0., ..., 0., 0., 0.],
         [0., 0., 0., ..., 0., 0., 0.],
         [0., 0., 0., ..., 0., 0., 0.]]]])
```

```

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 [0., 0., 0., ..., 0., 0., 0.],
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 [0., 0., 0., ..., 0., 0., 0.],
 [0., 0., 0., ..., 0., 0., 0.]]],

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  [0., 0., 0., ..., 0., 0., 0.],
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  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.]]],

 ...,

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  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  ...,
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.]],

 [[0., 0., 0., ..., 0., 0., 0.],

```

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[0., 0., 0., ..., 0., 0., 0.]],

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  [0., 0., 0., ..., 0., 0., 0.],
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  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.]]],

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  [0., 0., 0., 0., 0.]],

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[[0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
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 [0., 0., 0., 0., 0.],
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...,

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 [0., 0., 0., 0., 0.]],

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 [0., 0., 0., 0., 0.]],

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 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.]],

```

...

```

[[[0., 0., 0., 0., 0.],
  [0., 0., 0., 0., 0.],
  [0., 0., 0., 0., 0.],
  [0., 0., 0., 0., 0.],
  [0., 0., 0., 0., 0.]],

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 [0., 0., 0., 0., 0.]],

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```

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...

```

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...,

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 [0., 0., 0., 0., 0.]]],

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   [0., 0., 0., 0., 0.],

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[illegible]

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   [0., 0., 0.]]],

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   [0., 0., 0.]]],

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  [0., 0., 0.]]],

[[[0., 0., 0.],
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   [0., 0., 0.]],

```



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0., 0., 0., 0., 0., 0.])
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          [0., 0., 0.]],

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          [0., 0., 0.]],

        [[0., 0., 0.],
          [0., 0., 0.],
          [0., 0., 0.]],

        ...,

        [[0., 0., 0.],
          [0., 0., 0.],
          [0., 0., 0.]],

        [[0., 0., 0.],
          [0., 0., 0.],
          [0., 0., 0.]],

        [[0., 0., 0.],
          [0., 0., 0.],
          [0., 0., 0.]],

        ...,

        [[0., 0., 0.],
          [0., 0., 0.],
          [0., 0., 0.]]],

```

$$\begin{aligned}
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& [[0., 0., 0.], \\
& \quad [0., 0., 0.], \\
& \quad [0., 0., 0.]], \\
& [[0., 0., 0.], \\
& \quad [0., 0., 0.], \\
& \quad [0., 0., 0.]]], \\
& [[0., 0., 0.], \\
& \quad [0., 0., 0.], \\
& \quad [0., 0., 0.]], \\
& [[0., 0., 0.], \\
& \quad [0., 0., 0.], \\
& \quad [0., 0., 0.]], \\
& \dots, \\
& [[0., 0., 0.], \\
& \quad [0., 0., 0.], \\
& \quad [0., 0., 0.]], \\
& [[0., 0., 0.], \\
& \quad [0., 0., 0.], \\
& \quad [0., 0., 0.]], \\
& [[0., 0., 0.], \\
& \quad [0., 0., 0.], \\
& \quad [0., 0., 0.]]], \\
& \dots, \\
& [[0., 0., 0.], \\
& \quad [0., 0., 0.], \\
& \quad [0., 0., 0.]], \\
& [[0., 0., 0.], \\
& \quad [0., 0., 0.], \\
& \quad [0., 0., 0.]],
\end{aligned}$$

```

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 [0., 0., 0.]],

...,

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 [0., 0., 0.]],

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[[[0., 0., 0.],

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0., 0., 0., 0., 0.])
tensor([[[[0., 0., 0.],
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          [0., 0., 0.]],

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          [0., 0., 0.],
          [0., 0., 0.]],

        [[0., 0., 0.],
          [0., 0., 0.],
          [0., 0., 0.]],

        ...,

        [[0., 0., 0.],
          [0., 0., 0.],
          [0., 0., 0.]],

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          [0., 0., 0.]],

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1.8628e-06, 1.8633e-06, 1.8629e-06, 1.8628e-06, 1.8629e-06,
1.8631e-06, 1.8630e-06, 1.8629e-06, 1.8628e-06, 1.8627e-06])
end of p.grad

```

False

Epoch 19 finished

Epoch [19/45], Loss: 2.9535

\*\*\*\*\*

Learning rate: 0.005

another way to print learning rate:

```

tensor([[[[0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          ...,
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.]]]])

```

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...,
[0., 0., 0., ..., 0., 0., 0.],
[0., 0., 0., ..., 0., 0., 0.],
[0., 0., 0., ..., 0., 0., 0.]],
```

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...,
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[0., 0., 0., ..., 0., 0., 0.],
[0., 0., 0., ..., 0., 0., 0.]]],
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  [0., 0., 0., ..., 0., 0., 0.],
  ...,
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.]],
```

$$\begin{bmatrix} [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ \vdots, \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.] \end{bmatrix},$$

```
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[0., 0., 0., ..., 0., 0., 0.],
...,
[0., 0., 0., ..., 0., 0., 0.],
[0., 0., 0., ..., 0., 0., 0.],
[0., 0., 0., ..., 0., 0., 0.]]],
```

$$\begin{bmatrix} [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ \dots, \\ [0., 0., 0., \dots, 0., 0., 0.], \end{bmatrix}$$



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[illegible]

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[illegible]





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```





$\begin{bmatrix} 0. & 0. & 0. \\ 0. & 0. & 0. \\ 0. & 0. & 0. \end{bmatrix},$

...

$\begin{bmatrix} 0. & 0. & 0. \\ 0. & 0. & 0. \\ 0. & 0. & 0. \end{bmatrix},$

$\begin{bmatrix} 0. & 0. & 0. \\ 0. & 0. & 0. \\ 0. & 0. & 0. \end{bmatrix},$

$\begin{bmatrix} 0. & 0. & 0. \\ 0. & 0. & 0. \\ 0. & 0. & 0. \end{bmatrix}],$

$\begin{bmatrix} \begin{bmatrix} 0. & 0. & 0. \\ 0. & 0. & 0. \\ 0. & 0. & 0. \end{bmatrix},$

$\begin{bmatrix} 0. & 0. & 0. \\ 0. & 0. & 0. \\ 0. & 0. & 0. \end{bmatrix},$

$\begin{bmatrix} 0. & 0. & 0. \\ 0. & 0. & 0. \\ 0. & 0. & 0. \end{bmatrix},$

...

$\begin{bmatrix} 0. & 0. & 0. \\ 0. & 0. & 0. \\ 0. & 0. & 0. \end{bmatrix},$

$\begin{bmatrix} 0. & 0. & 0. \\ 0. & 0. & 0. \\ 0. & 0. & 0. \end{bmatrix},$

$\begin{bmatrix} 0. & 0. & 0. \\ 0. & 0. & 0. \\ 0. & 0. & 0. \end{bmatrix}],$

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 1.5501e-06, 1.5501e-06, 1.5500e-06, 1.5504e-06, 1.5503e-06,  
 1.5504e-06, 1.5499e-06, 1.5496e-06, 1.5501e-06, 1.5505e-06,  
 1.5496e-06, 1.5496e-06, 1.5500e-06, 1.5501e-06, 1.5506e-06,  
 1.5503e-06, 1.5504e-06, 1.5504e-06, 1.5506e-06, 1.5503e-06,  
 1.5502e-06, 1.5504e-06, 1.5505e-06, 1.5502e-06, 1.5501e-06,  
 1.5481e-06, 1.5503e-06, 1.5502e-06, 1.5504e-06, 1.5502e-06,  
 1.5505e-06, 1.5501e-06, 1.5503e-06, 1.5505e-06, 1.5504e-06,  
 1.5501e-06, 1.5501e-06, 1.5505e-06, 1.5505e-06, 1.5503e-06,  
 1.5506e-06, 1.5503e-06, 1.5503e-06, 1.5505e-06, 1.5498e-06,  
 1.5502e-06, 1.5505e-06, 1.5494e-06, 1.5501e-06, 1.5503e-06,  
 1.5505e-06, 1.5501e-06, 1.5504e-06, 1.5504e-06, 1.5499e-06,  
 1.5504e-06, 1.5502e-06, 1.5495e-06, 1.5500e-06, 1.5505e-06,  
 1.5496e-06, 1.5495e-06, 1.5497e-06, 1.5487e-06, 1.5500e-06,  
 1.5501e-06, 1.5505e-06, 1.5492e-06, 1.5504e-06, 1.5505e-06,

```

1.5506e-06, 1.5503e-06, 1.5502e-06, 1.5500e-06, 1.5503e-06,
1.5505e-06, 1.5504e-06, 1.5494e-06, 1.5499e-06, 1.5502e-06,
1.5503e-06, 1.5504e-06, 1.5500e-06, 1.5494e-06, 1.5490e-06,
1.5502e-06, 1.5500e-06, 1.5499e-06, 1.5504e-06, 1.5503e-06,
1.5502e-06, 1.5503e-06, 1.5492e-06, 1.5501e-06, 1.5499e-06,
1.5503e-06, 1.5499e-06, 1.5495e-06, 1.5484e-06, 1.5498e-06,
1.5499e-06, 1.5504e-06, 1.5499e-06, 1.5505e-06, 1.5505e-06,
1.5506e-06, 1.5505e-06, 1.5502e-06, 1.5500e-06, 1.5503e-06,
1.5496e-06, 1.5505e-06, 1.5503e-06, 1.5497e-06, 1.5504e-06,
1.5496e-06, 1.5496e-06, 1.5506e-06, 1.5504e-06, 1.5497e-06,
1.5501e-06, 1.5505e-06, 1.5504e-06, 1.5505e-06, 1.5505e-06,
1.5499e-06, 1.5493e-06, 1.5503e-06, 1.5498e-06, 1.5504e-06,
1.5505e-06, 1.5505e-06, 1.5501e-06, 1.5504e-06, 1.5502e-06,
1.5499e-06, 1.5505e-06, 1.5500e-06, 1.5499e-06, 1.5500e-06,
1.5501e-06, 1.5501e-06, 1.5500e-06, 1.5496e-06, 1.5494e-06])
end of p.grad

```

False

Epoch 20 finished

Epoch [20/45], Loss: 3.0267

\*\*\*\*\*

Learning rate: 0.005

another way to print learning rate:

```

tensor([[[[0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          ...,
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.]],
        [[0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          ...,
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.]],
        [[0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          ...,
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.]]],

```

$$\begin{bmatrix} [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ \vdots, \\ [0., 0., 0., \dots, 0., 0., 0.], \end{bmatrix}$$

```
[0., 0., 0., ..., 0., 0., 0.],
[0., 0., 0., ..., 0., 0., 0.]]],
```

```
...,
```

```
[[[0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  ...,
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.]]],
```

```
[[0., 0., 0., ..., 0., 0., 0.],
 [0., 0., 0., ..., 0., 0., 0.],
 [0., 0., 0., ..., 0., 0., 0.],
 ...,
 [0., 0., 0., ..., 0., 0., 0.],
 [0., 0., 0., ..., 0., 0., 0.],
 [0., 0., 0., ..., 0., 0., 0.]]],
```

```
[[0., 0., 0., ..., 0., 0., 0.],
 [0., 0., 0., ..., 0., 0., 0.],
 [0., 0., 0., ..., 0., 0., 0.],
 ...,
 [0., 0., 0., ..., 0., 0., 0.],
 [0., 0., 0., ..., 0., 0., 0.],
 [0., 0., 0., ..., 0., 0., 0.]]],
```

```
[[[0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  ...,
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.]]],
```

```
[[0., 0., 0., ..., 0., 0., 0.],
 [0., 0., 0., ..., 0., 0., 0.],
 [0., 0., 0., ..., 0., 0., 0.],
 ...,
 [0., 0., 0., ..., 0., 0., 0.],
 [0., 0., 0., ..., 0., 0., 0.],
 [0., 0., 0., ..., 0., 0., 0.]]],
```



```

tensor([0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
0., 0., 0., 0., 0., 0.,
        0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
0., 0., 0., 0., 0., 0.,
        0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
0., 0., 0., 0., 0., 0.,
        0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
0., 0., 0., 0., 0., 0.])
tensor([[[[0., 0., 0., 0., 0.],
          [0., 0., 0., 0., 0.],
          [0., 0., 0., 0., 0.],
          [0., 0., 0., 0., 0.],
          [0., 0., 0., 0., 0.]],

        [[0., 0., 0., 0., 0.],
          [0., 0., 0., 0., 0.],
          [0., 0., 0., 0., 0.],
          [0., 0., 0., 0., 0.],
          [0., 0., 0., 0., 0.]],

        [[0., 0., 0., 0., 0.],
          [0., 0., 0., 0., 0.],
          [0., 0., 0., 0., 0.],
          [0., 0., 0., 0., 0.],
          [0., 0., 0., 0., 0.]],

        ...,

        [[0., 0., 0., 0., 0.],
          [0., 0., 0., 0., 0.],
          [0., 0., 0., 0., 0.],
          [0., 0., 0., 0., 0.],
          [0., 0., 0., 0., 0.]],

        [[0., 0., 0., 0., 0.],
          [0., 0., 0., 0., 0.],
          [0., 0., 0., 0., 0.],
          [0., 0., 0., 0., 0.],
          [0., 0., 0., 0., 0.]],

        [[0., 0., 0., 0., 0.],
          [0., 0., 0., 0., 0.],
          [0., 0., 0., 0., 0.],
          [0., 0., 0., 0., 0.],
          [0., 0., 0., 0., 0.]]],

        [[[0., 0., 0., 0., 0.],

```

```

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[0., 0., 0., 0., 0.]],

[[0., 0., 0., 0., 0.],
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 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.]],

[[0., 0., 0., 0., 0.],
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 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.]],

...,

[[0., 0., 0., 0., 0.],
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 [0., 0., 0., 0., 0.]],

[[0., 0., 0., 0., 0.],
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 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.]],

[[0., 0., 0., 0., 0.],
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 [0., 0., 0., 0., 0.]],

[[[0., 0., 0., 0., 0.],
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  [0., 0., 0., 0., 0.],
  [0., 0., 0., 0., 0.]],

[[0., 0., 0., 0., 0.],
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 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],

```

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...,

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 [0., 0., 0., 0., 0.]],

[[0., 0., 0., 0., 0.],
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 [0., 0., 0., 0., 0.]],

...,

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  [0., 0., 0., 0., 0.],
  [0., 0., 0., 0., 0.]],

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 [0., 0., 0., 0., 0.]],

[[0., 0., 0., 0., 0.],
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 [0., 0., 0., 0., 0.],
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 [0., 0., 0., 0., 0.]]],

```



```

[0., 0., 0., 0., 0.]],

...,

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 [0., 0., 0., 0., 0.]]],

[[[0., 0., 0., 0., 0.],
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  [0., 0., 0., 0., 0.],
  [0., 0., 0., 0., 0.]],

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[[0., 0., 0., 0., 0.],
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 [0., 0., 0., 0., 0.]],

...,

[[0., 0., 0., 0., 0.],
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```

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```

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 [0., 0., 0., 0., 0.]]],
```

```
[[[0., 0., 0., 0., 0.],
  [0., 0., 0., 0., 0.],
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```

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```

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...,

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 [0., 0., 0., 0., 0.]],
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```

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[[0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
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[illegible]

[illegible]

```
tensor([[[[0., 0., 0.],
          [0., 0., 0.],
          [0., 0., 0.]]],
```

```
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 [0., 0., 0.]],
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 [0., 0., 0.]],
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...

```
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 [0., 0., 0.]],
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```
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 [0., 0., 0.]]],
```

```
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    [0., 0., 0.],
    [0., 0., 0.]],
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[0., 0., 0.]],

[[0., 0., 0.],  
[0., 0., 0.],

```

[0., 0., 0.]],

...,

[[[0., 0., 0.],
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  [0., 0., 0.]],

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  [0., 0., 0.]],

 ...,

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  [0., 0., 0.]],

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  [0., 0., 0.]],

 [[0., 0., 0.],
  [0., 0., 0.],
  [0., 0., 0.]],

 ...,

 [[0., 0., 0.],

```



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0., 0., 0., 0., 0., 0.,
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0., 0., 0., 0., 0., 0.,
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0., 0., 0., 0., 0., 0.,
    0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
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    0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
0., 0., 0., 0., 0., 0.,
    0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
0., 0., 0., 0., 0., 0.]
tensor([[[[0., 0., 0.],
          [0., 0., 0.],
          [0., 0., 0.]],

        [[0., 0., 0.],
          [0., 0., 0.],
          [0., 0., 0.]],

        [[0., 0., 0.],
          [0., 0., 0.],
          [0., 0., 0.]],

        ...,

        [[0., 0., 0.],
          [0., 0., 0.],
          [0., 0., 0.]],

        [[0., 0., 0.],
          [0., 0., 0.],
          [0., 0., 0.]],

        [[0., 0., 0.],
          [0., 0., 0.],
          [0., 0., 0.]]],

```



```

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  [0., 0., 0.]],

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  [0., 0., 0.]],

[[0., 0., 0.],
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  [0., 0., 0.]],

...,

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  [0., 0., 0.]],

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  [0., 0., 0.]],

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  [0., 0., 0.]]],

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  [0., 0., 0.]],

...,

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  [0., 0., 0.]],

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  [0., 0., 0.]]],

[[[0., 0., 0.],
  [0., 0., 0.],
  [0., 0., 0.]]],

```

```
[[0., 0., 0.],
 [0., 0., 0.],
 [0., 0., 0.]]],
```

...,

```
[[[0., 0., 0.],
   [0., 0., 0.],
   [0., 0., 0.]],
```

```
[0., 0., 0.],
 [0., 0., 0.],
 [0., 0., 0.]],
```

```
[0., 0., 0.],
 [0., 0., 0.],
 [0., 0., 0.]],
```

...,

```
[0., 0., 0.],
 [0., 0., 0.],
 [0., 0., 0.]],
```

```
[0., 0., 0.],
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 [0., 0., 0.]],
```

```
[0., 0., 0.],
 [0., 0., 0.],
 [0., 0., 0.]]],
```

```
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   [0., 0., 0.]],
```

```
[0., 0., 0.],
 [0., 0., 0.],
 [0., 0., 0.]],
```

```
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 [0., 0., 0.],
 [0., 0., 0.]],
```





```

[0., 0., 0.]],

[[[0., 0., 0.],
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  [0., 0., 0.]],

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  [0., 0., 0.]],

 [[0., 0., 0.],
  [0., 0., 0.],
  [0., 0., 0.]],

 ...,

 [[0., 0., 0.],
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  [0., 0., 0.]],

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  [0., 0., 0.]],

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  [0., 0., 0.],
  [0., 0., 0.]],

 ...,

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  [0., 0., 0.]],

```

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 [0., 0., 0.]],
```

```
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 [0., 0., 0.],
 [0., 0., 0.]],
```

...

```
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    [0., 0., 0.],
    [0., 0., 0.]],
```

```
[[0., 0., 0.],
 [0., 0., 0.],
 [0., 0., 0.]],
```

$$\begin{bmatrix} [0., 0., 0.], \\ [0., 0., 0.], \\ [0., 0., 0.] \end{bmatrix},$$

...

```
[[0., 0., 0.],
 [0., 0., 0.],
 [0., 0., 0.]],
```

```
[[0., 0., 0.],
 [0., 0., 0.],
 [0., 0., 0.]],
```

```
[[0., 0., 0.],
 [0., 0., 0.],
 [0., 0., 0.]],
```

$$\begin{bmatrix} [0., 0., 0.], \\ [0., 0., 0.], \\ [0., 0., 0.] \end{bmatrix},$$

```
[[0., 0., 0.],
 [0., 0., 0.],
 [0., 0., 0.]],
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end of p.grad

```
False
Epoch 21 finished
Epoch [21/45], Loss: 3.0062
*****
```

Learning rate: 0.005

another way to print learning rate:

```
tensor([[[[0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          ...,
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.]],
        [[0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          ...,
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.]],
        [[0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          ...,
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.]]],
       ...])
```

```

[0., 0., 0., ..., 0., 0., 0.]],

[[0., 0., 0., ..., 0., 0., 0.],
 [0., 0., 0., ..., 0., 0., 0.],
 [0., 0., 0., ..., 0., 0., 0.],
 ...,
 [0., 0., 0., ..., 0., 0., 0.],
 [0., 0., 0., ..., 0., 0., 0.],
 [0., 0., 0., ..., 0., 0., 0.]]],

[[[0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  ...,
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.]],

 [[0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  ...,
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.]],

 [[0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  ...,
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.]]],

 ...,

[[[0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  ...,
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.]],

 [[0., 0., 0., ..., 0., 0., 0.],

```

```

[0., 0., 0., ..., 0., 0., 0.],
[0., 0., 0., ..., 0., 0., 0.],
...,
[0., 0., 0., ..., 0., 0., 0.],
[0., 0., 0., ..., 0., 0., 0.],
[0., 0., 0., ..., 0., 0., 0.]],

[[[0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  ...,
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.]],

[[[0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  ...,
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.]],

[[[0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  ...,
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.]]],

[[[0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  ...,
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.]]],

```





```

[0., 0., 0., 0., 0.],
[0., 0., 0., 0., 0.],
[0., 0., 0., 0., 0.]],

[[0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.]],

...,

[[0., 0., 0., 0., 0.],
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 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.]],

[[0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.]],

[[0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.]]],

[[[0., 0., 0., 0., 0.],
  [0., 0., 0., 0., 0.],
  [0., 0., 0., 0., 0.],
  [0., 0., 0., 0., 0.],
  [0., 0., 0., 0., 0.]],

[[0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.]],

[[0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.]]],

```

```

...,

[[0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.]],

[[0., 0., 0., 0., 0.],
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 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.]],

[[0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.]]],

[[[0., 0., 0., 0., 0.],
  [0., 0., 0., 0., 0.],
  [0., 0., 0., 0., 0.],
  [0., 0., 0., 0., 0.],
  [0., 0., 0., 0., 0.]],

[[0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.]],

[[0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.]],

...,

[[0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.]],

```

```
[[0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.]],
```

```
[[0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.]]],
```

...,

```
[[[0., 0., 0., 0., 0.],
   [0., 0., 0., 0., 0.],
   [0., 0., 0., 0., 0.],
   [0., 0., 0., 0., 0.],
   [0., 0., 0., 0., 0.]],
```

```
[[0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.]],
```

```
[[0., 0., 0., 0., 0.],
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 [0., 0., 0., 0., 0.]],
```

...,

```
[[0., 0., 0., 0., 0.],
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 [0., 0., 0., 0., 0.]],
```

```
[[0., 0., 0., 0., 0.],
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 [0., 0., 0., 0., 0.]],
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```

[[0., 0., 0., 0., 0.],
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```

[[[0., 0., 0., 0., 0.],
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   [0., 0., 0., 0., 0.]],

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```

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 [0., 0., 0., 0., 0.]],

```

```

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 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.]],

```

...,

```

[[0., 0., 0., 0., 0.],
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 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.]],

```

```

[[0., 0., 0., 0., 0.],
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 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.]],

```

```

[[0., 0., 0., 0., 0.],
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 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.],
 [0., 0., 0., 0., 0.]]],

```

```

[[[0., 0., 0., 0., 0.],
   [0., 0., 0., 0., 0.],

```



[illegible]

```
0., 0., 0., 0., 0., 0.,
      0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.])
```

```

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    [0., 0., 0.]],

[[[0., 0., 0.],
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   [0., 0., 0.]]],

[[[0., 0., 0.],
   [0., 0., 0.],
   [0., 0., 0.]],

[[0., 0., 0.],
   [0., 0., 0.],
   [0., 0., 0.]],

[[0., 0., 0.],
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   [0., 0., 0.]],

...,

[[[0., 0., 0.],
   [0., 0., 0.],
   [0., 0., 0.]],

[[0., 0., 0.],
   [0., 0., 0.],
   [0., 0., 0.]],

[[0., 0., 0.],
   [0., 0., 0.],
   [0., 0., 0.]]],

...,

[[[0., 0., 0.],
   [0., 0., 0.],
   [0., 0., 0.]],

[[0., 0., 0.],
   [0., 0., 0.],
   [0., 0., 0.]],

[[0., 0., 0.],
   [0., 0., 0.],
   [0., 0., 0.]]],

```



```

    [0., 0., 0.]],

...,

[[[0., 0., 0.],
   [0., 0., 0.],
   [0., 0., 0.]],

 [[0., 0., 0.],
  [0., 0., 0.],
  [0., 0., 0.]],

 [[0., 0., 0.],
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  [0., 0., 0.]]],

[[[0., 0., 0.],
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   [0., 0., 0.]],

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  [0., 0., 0.],
  [0., 0., 0.]],

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  [0., 0., 0.],
  [0., 0., 0.]],

 ...,

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  [0., 0., 0.],
  [0., 0., 0.]],

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  [0., 0., 0.],
  [0., 0., 0.]],

 [[0., 0., 0.],
  [0., 0., 0.],
  [0., 0., 0.]]],

[[[0., 0., 0.],
   [0., 0., 0.],
   [0., 0., 0.]],

```



```

0., 0., 0., 0., 0., 0.,
    0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
0., 0., 0., 0., 0., 0.,
    0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
0., 0., 0., 0., 0., 0.])
tensor([[[[0., 0., 0.],
          [0., 0., 0.],
          [0., 0., 0.]],

        [[0., 0., 0.],
          [0., 0., 0.],
          [0., 0., 0.]],

        [[0., 0., 0.],
          [0., 0., 0.],
          [0., 0., 0.]],

        ...,

        [[0., 0., 0.],
          [0., 0., 0.],
          [0., 0., 0.]],

        [[0., 0., 0.],
          [0., 0., 0.],
          [0., 0., 0.]],

        [[0., 0., 0.],
          [0., 0., 0.],
          [0., 0., 0.]],

        ...,

        [[0., 0., 0.],
          [0., 0., 0.],
          [0., 0., 0.]]],

```

```

    [0., 0., 0.]],

    [[0., 0., 0.],
     [0., 0., 0.],
     [0., 0., 0.]],

    [[0., 0., 0.],
     [0., 0., 0.],
     [0., 0., 0.]]],

    [[[0., 0., 0.],
      [0., 0., 0.],
      [0., 0., 0.]],

     [[0., 0., 0.],
      [0., 0., 0.],
      [0., 0., 0.]],

     [[0., 0., 0.],
      [0., 0., 0.],
      [0., 0., 0.]]],

    ...,

    [[[0., 0., 0.],
      [0., 0., 0.],
      [0., 0., 0.]],

     [[0., 0., 0.],
      [0., 0., 0.],
      [0., 0., 0.]],

     [[0., 0., 0.],
      [0., 0., 0.],
      [0., 0., 0.]]],

    ...,

    [[[0., 0., 0.],
      [0., 0., 0.],
      [0., 0., 0.]],

     [[0., 0., 0.],
      [0., 0., 0.],
      [0., 0., 0.]],

     [[0., 0., 0.],
      [0., 0., 0.],
      [0., 0., 0.]]],

```

```
[[0., 0., 0.],  
 [0., 0., 0.],  
 [0., 0., 0.]],
```

...,

```
[[0., 0., 0.],  
 [0., 0., 0.],  
 [0., 0., 0.]],
```

```
[[0., 0., 0.],  
 [0., 0., 0.],  
 [0., 0., 0.]],
```

```
[[0., 0., 0.],  
 [0., 0., 0.],  
 [0., 0., 0.]]],
```

```
[[[0., 0., 0.],  
   [0., 0., 0.],  
   [0., 0., 0.]],
```

```
[[0., 0., 0.],  
 [0., 0., 0.],  
 [0., 0., 0.]],
```

```
[[0., 0., 0.],  
 [0., 0., 0.],  
 [0., 0., 0.]],
```

...,

```
[[0., 0., 0.],  
 [0., 0., 0.],  
 [0., 0., 0.]],
```

```
[[0., 0., 0.],  
 [0., 0., 0.],  
 [0., 0., 0.]],
```

```
[[0., 0., 0.],  
 [0., 0., 0.],  
 [0., 0., 0.]]],
```

```
[[[0., 0., 0.],
```



```

0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
0., 0., 0., 0., 0., 0.,
0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
0., 0., 0., 0., 0.,
0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
0., 0., 0., 0., 0.,
0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
0., 0., 0., 0., 0., 0.])
tensor([[[[0., 0., 0.],
          [0., 0., 0.],
          [0., 0., 0.]],

        [[0., 0., 0.],
          [0., 0., 0.],
          [0., 0., 0.]],

        [[0., 0., 0.],
          [0., 0., 0.],
          [0., 0., 0.]],

        ...,

        [[0., 0., 0.],
          [0., 0., 0.],
          [0., 0., 0.]],

        [[0., 0., 0.],
          [0., 0., 0.],
          [0., 0., 0.]],

        [[0., 0., 0.],
          [0., 0., 0.],
          [0., 0., 0.]],

        ...,

        [[0., 0., 0.],
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          [0., 0., 0.]],

        [[0., 0., 0.],
          [0., 0., 0.],
          [0., 0., 0.]],

        ...,

```

```

[[0., 0., 0.],
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 [0., 0., 0.]],

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 [0., 0., 0.]]],

[[[0., 0., 0.],
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  [0., 0., 0.]],

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  [0., 0., 0.]],

 [[0., 0., 0.],
  [0., 0., 0.],
  [0., 0., 0.]],

 ...,

 [[0., 0., 0.],
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  [0., 0., 0.]],

 [[0., 0., 0.],
  [0., 0., 0.],
  [0., 0., 0.]],

 [[0., 0., 0.],
  [0., 0., 0.],
  [0., 0., 0.]]],

 ...,

 [[[0., 0., 0.],
  [0., 0., 0.],
  [0., 0., 0.]],

```



```

[[0., 0., 0.],
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 [0., 0., 0.]],

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 [0., 0., 0.]],

...,

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[[0., 0., 0.],
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 [0., 0., 0.]]],

```

```

[[[0., 0., 0.],
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  [0., 0., 0.]],

 [[0., 0., 0.],
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  [0., 0., 0.]],

```

```

...,

[[0., 0., 0.],
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 [0., 0., 0.]],

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 [0., 0., 0.],
 [0., 0., 0.]],

[[0., 0., 0.],
 [0., 0., 0.],
 [0., 0., 0.]]],

```



```

tensor([[0., 0., 0., ..., 0., 0., 0.],
        [0., 0., 0., ..., 0., 0., 0.],
        [0., 0., 0., ..., 0., 0., 0.],
        ...,
        [0., 0., 0., ..., 0., 0., 0.],
        [0., 0., 0., ..., 0., 0., 0.],
        [0., 0., 0., ..., 0., 0., 0.]])
tensor([0., 0., 0., ..., 0., 0., 0.])
tensor([[0., 0., 0., ..., 0., 0., 0.],
        [0., 0., 0., ..., 0., 0., 0.],
        [0., 0., 0., ..., 0., 0., 0.],
        ...,
        [0., 0., 0., ..., 0., 0., 0.],
        [0., 0., 0., ..., 0., 0., 0.],
        [0., 0., 0., ..., 0., 0., 0.]])
tensor([0., 0., 0., ..., 0., 0., 0.])
tensor([[0., 0., 0., ..., 0., 0., 0.],
        [0., 0., 0., ..., 0., 0., 0.],
        [0., 0., 0., ..., 0., 0., 0.],
        ...,
        [0., 0., 0., ..., 0., 0., 0.],
        [0., 0., 0., ..., 0., 0., 0.],
        [0., 0., 0., ..., 0., 0., 0.]])
tensor([ 4.7765e-02, -7.9942e-03, -1.4149e-01,  5.0372e-02, -1.2671e-02,
        -1.2913e-02,  5.1302e-02, -1.8325e-02,  5.1231e-02, -8.1937e-02,
        -7.2908e-02, -1.0216e-02, -2.6987e-03, -1.2873e-02, -1.1343e-02,
        4.7461e-02,  4.5254e-02,  4.7686e-02, -3.1307e-03,  4.5861e-02,
        3.3247e-06,  1.5985e-06,  1.5987e-06,  1.5986e-06,  1.5988e-06,
        1.5986e-06,  1.5987e-06,  1.5986e-06,  1.5987e-06,  1.5985e-06,
        1.5985e-06,  1.5996e-06,  1.5997e-06,  1.5985e-06,  1.5985e-06,
        1.5989e-06,  1.5992e-06,  1.5987e-06,  1.5987e-06,  1.5987e-06,
        1.5985e-06,  1.5985e-06,  1.5985e-06,  1.5985e-06,  1.5986e-06,
        1.5985e-06,  1.5988e-06,  1.5986e-06,  1.5985e-06,  1.5989e-06,
        1.5984e-06,  1.5985e-06,  1.5989e-06,  1.5985e-06,  1.5985e-06,
        1.5988e-06,  1.5988e-06,  1.5985e-06,  1.5986e-06,  1.5986e-06,
        1.5986e-06,  1.5985e-06,  1.5985e-06,  1.5986e-06,  1.5985e-06,
        1.5990e-06,  1.5985e-06,  1.5985e-06,  1.5986e-06,  1.5986e-06,
        1.5985e-06,  1.5985e-06,  1.5986e-06,  1.5985e-06,  1.5987e-06,
        1.5987e-06,  1.5985e-06,  1.5985e-06,  1.5986e-06,  1.5986e-06,
        1.5985e-06,  1.5986e-06,  1.5985e-06,  1.5986e-06,  1.5987e-06,
        1.5986e-06,  1.5986e-06,  1.5985e-06,  1.5985e-06,  1.5988e-06,
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        1.5984e-06,  1.5985e-06,  1.5985e-06,  1.5986e-06,  1.5985e-06,
        1.5985e-06,  1.5987e-06,  1.5986e-06,  1.5985e-06,  1.5987e-06,
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        1.5986e-06,  1.5986e-06,  1.5985e-06,  1.5985e-06,  1.5988e-06,
        1.5988e-06,  1.5986e-06,  1.5985e-06,  1.5985e-06,  1.5986e-06])

```

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[illegible]

[illegible]

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1.5985e-06, 1.5985e-06, 1.5985e-06, 1.5987e-06, 1.5988e-06])
end of p.grad

```

False

Epoch 22 finished

Epoch [22/45], Loss: 3.0023

\*\*\*\*\*

Learning rate: 0.005

another way to print learning rate:

```

tensor([[[[0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          ...,
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.]]]])

```

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...,
[0., 0., 0., ..., 0., 0., 0.],
[0., 0., 0., ..., 0., 0., 0.],
[0., 0., 0., ..., 0., 0., 0.]],
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[0., 0., 0., ..., 0., 0., 0.],
...,
[0., 0., 0., ..., 0., 0., 0.],
[0., 0., 0., ..., 0., 0., 0.],
[0., 0., 0., ..., 0., 0., 0.]]],
```

```
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  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  ...,
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.]],
```

$$\begin{bmatrix} [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ \vdots, \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.] \end{bmatrix},$$

```
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[0., 0., 0., ..., 0., 0., 0.],
[0., 0., 0., ..., 0., 0., 0.],
...,
[0., 0., 0., ..., 0., 0., 0.],
[0., 0., 0., ..., 0., 0., 0.],
[0., 0., 0., ..., 0., 0., 0.]]],
```

$$\begin{bmatrix} [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ \vdots, \\ [0., 0., 0., \dots, 0., 0., 0.], \end{bmatrix}$$



```

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[illegible]



[illegible]

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```





$\begin{bmatrix} 0. & 0. & 0. \\ 0. & 0. & 0. \\ 0. & 0. & 0. \end{bmatrix},$

...

$\begin{bmatrix} 0. & 0. & 0. \\ 0. & 0. & 0. \\ 0. & 0. & 0. \end{bmatrix},$

$\begin{bmatrix} 0. & 0. & 0. \\ 0. & 0. & 0. \\ 0. & 0. & 0. \end{bmatrix},$

$\begin{bmatrix} 0. & 0. & 0. \\ 0. & 0. & 0. \\ 0. & 0. & 0. \end{bmatrix}],$

$\begin{bmatrix} \begin{bmatrix} 0. & 0. & 0. \\ 0. & 0. & 0. \\ 0. & 0. & 0. \end{bmatrix},$

$\begin{bmatrix} 0. & 0. & 0. \\ 0. & 0. & 0. \\ 0. & 0. & 0. \end{bmatrix},$

$\begin{bmatrix} 0. & 0. & 0. \\ 0. & 0. & 0. \\ 0. & 0. & 0. \end{bmatrix},$

...

$\begin{bmatrix} 0. & 0. & 0. \\ 0. & 0. & 0. \\ 0. & 0. & 0. \end{bmatrix},$

$\begin{bmatrix} 0. & 0. & 0. \\ 0. & 0. & 0. \\ 0. & 0. & 0. \end{bmatrix},$

$\begin{bmatrix} 0. & 0. & 0. \\ 0. & 0. & 0. \\ 0. & 0. & 0. \end{bmatrix}],$

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        [0., 0., 0., ..., 0., 0., 0.],
        [0., 0., 0., ..., 0., 0., 0.]])
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        -7.5212e-02,  4.9025e-02, -1.9001e-02,  5.1165e-02, -1.0401e-02,
        -1.0599e-02, -1.6350e-02, -5.5252e-03, -1.6593e-02,  5.7360e-02,
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        1.7221e-06,  1.7224e-06,  1.7222e-06,  1.7222e-06,  1.7222e-06,
        1.7222e-06,  1.7229e-06,  1.7229e-06,  1.7222e-06,  1.7222e-06,
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        1.7222e-06,  1.7222e-06,  1.7222e-06,  1.7221e-06,  1.7222e-06,
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        1.7222e-06,  1.7222e-06,  1.7223e-06,  1.7222e-06,  1.7222e-06,
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[illegible]

[illegible]



[illegible]

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1.7221e-06, 1.7221e-06, 1.7222e-06, 1.7222e-06, 1.7223e-06])
end of p.grad

```

False

Epoch 23 finished

Epoch [23/45], Loss: 2.9968

\*\*\*\*\*

Learning rate: 0.005

another way to print learning rate:

```

tensor([[[[0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          ...,
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          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.]],
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          ...,
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          [0., 0., 0., ..., 0., 0., 0.],
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          [0., 0., 0., ..., 0., 0., 0.],
          ...,
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.],
          [0., 0., 0., ..., 0., 0., 0.]]],

```

$$\begin{bmatrix} [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ [0., 0., 0., \dots, 0., 0., 0.], \\ \dots, \\ [0., 0., 0., \dots, 0., 0., 0.], \end{bmatrix}$$

```
[0., 0., 0., ..., 0., 0., 0.],
[0., 0., 0., ..., 0., 0., 0.]]],
```

```
...,
```

```
[[[0., 0., 0., ..., 0., 0., 0.],
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  [0., 0., 0., ..., 0., 0., 0.],
  ...,
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  [0., 0., 0., ..., 0., 0., 0.],
  [0., 0., 0., ..., 0., 0., 0.]]],
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0., 0., 0., 0., 0., 0.])
tensor([[[[0., 0., 0., 0., 0.],
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[illegible]

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end of p.grad

False

Epoch 25 finished

Epoch [25/45], Loss: 3.0407

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Learning rate: 0.005

another way to print learning rate:

[illegible]









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1.8327e-06, 1.8328e-06, 1.8329e-06, 1.8331e-06, 1.8334e-06])
end of p.grad

```

False

Epoch 26 finished

Epoch [26/45], Loss: 3.0009

\*\*\*\*\*

Learning rate: 0.005

another way to print learning rate:

```

tensor([[[[0., 0., 0., ..., 0., 0., 0.],
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[illegible]



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1.7803e-06, 1.7803e-06, 1.7802e-06, 1.7802e-06, 1.7801e-06])

```

end of p.grad

False

Epoch 27 finished

Epoch [27/45], Loss: 3.0063

\*\*\*\*\*

```

-----
KeyboardInterrupt                                Traceback (most recent call last)
Cell In[12], line 26
    23 for inputs, labels in dataloader:
    25     optimizer.zero_grad()
--> 26     outputs = model(inputs)
    27     Before = list(model.parameters())[0].clone()
    29     loss = criterion(outputs, labels)

File C:\Apps installed by
↳ Lim\anaconda3\Lib\site-packages\torch\nn\modules\module.py:1511, in Module.
↳ _wrapped_call_impl(self, *args, **kwargs)
    1509     return self._compiled_call_impl(*args, **kwargs) # type:
↳ ignore[misc]
    1510 else:
-> 1511     return self._call_impl(*args, **kwargs)

File C:\Apps installed by
↳ Lim\anaconda3\Lib\site-packages\torch\nn\modules\module.py:1520, in Module.
↳ _call_impl(self, *args, **kwargs)
    1515 # If we don't have any hooks, we want to skip the rest of the logic in
    1516 # this function, and just call forward.
    1517 if not (self._backward_hooks or self._backward_pre_hooks or self.
↳ _forward_hooks or self._forward_pre_hooks
    1518         or _global_backward_pre_hooks or _global_backward_hooks
    1519         or _global_forward_hooks or _global_forward_pre_hooks):
-> 1520     return forward_call(*args, **kwargs)

```

```

1522 try:
1523     result = None

Cell In[2], line 34, in AlexNet.forward(self, x)
    33 def forward(self, x: torch.Tensor) -> torch.Tensor:
---> 34     x = self.features(x)
    35     x = self.avgpool(x)
    36     x = torch.flatten(x, 1)

File C:\Apps installed by
↳ Lim\anaconda3\Lib\site-packages\torch\nn\modules\module.py:1511, in Module.
↳ _wrapped_call_impl(self, *args, **kwargs)
    1509     return self._compiled_call_impl(*args, **kwargs) # type:
↳ ignore[misc]
    1510 else:
-> 1511     return self._call_impl(*args, **kwargs)

File C:\Apps installed by
↳ Lim\anaconda3\Lib\site-packages\torch\nn\modules\module.py:1520, in Module.
↳ _call_impl(self, *args, **kwargs)
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    1518         or _global_backward_pre_hooks or _global_backward_hooks
    1519         or _global_forward_hooks or _global_forward_pre_hooks):
-> 1520     return forward_call(*args, **kwargs)
    1522 try:
    1523     result = None

File C:\Apps installed by
↳ Lim\anaconda3\Lib\site-packages\torch\nn\modules\container.py:217, in
↳ Sequential.forward(self, input)
    215 def forward(self, input):
    216     for module in self:
--> 217         input = module(input)
    218     return input

File C:\Apps installed by
↳ Lim\anaconda3\Lib\site-packages\torch\nn\modules\module.py:1511, in Module.
↳ _wrapped_call_impl(self, *args, **kwargs)
    1509     return self._compiled_call_impl(*args, **kwargs) # type:
↳ ignore[misc]
    1510 else:
-> 1511     return self._call_impl(*args, **kwargs)

File C:\Apps installed by
↳ Lim\anaconda3\Lib\site-packages\torch\nn\modules\module.py:1520, in Module.
↳ _call_impl(self, *args, **kwargs)

```

```

1515 # If we don't have any hooks, we want to skip the rest of the logic in
1516 # this function, and just call forward.
1517 if not (self._backward_hooks or self._backward_pre_hooks or self.
↪ _forward_hooks or self._forward_pre_hooks
1518         or _global_backward_pre_hooks or _global_backward_hooks
1519         or _global_forward_hooks or _global_forward_pre_hooks):
-> 1520     return forward_call(*args, **kwargs)
1522 try:
1523     result = None

```

File C:\Apps installed by Lim\anaconda3\Lib\site-packages\torch\nn\modules\conv  
↪ py:460, in Conv2d.forward(self, input)

```

459 def forward(self, input: Tensor) -> Tensor:
--> 460     return self._conv_forward(input, self.weight, self.bias)

```

File C:\Apps installed by Lim\anaconda3\Lib\site-packages\torch\nn\modules\conv  
↪ py:456, in Conv2d.\_conv\_forward(self, input, weight, bias)

```

452 if self.padding_mode != 'zeros':
453     return F.conv2d(F.pad(input, self._reversed_padding_repeated_twice,
↪ mode=self.padding_mode),
454                     weight, bias, self.stride,
455                     _pair(0), self.dilation, self.groups)
--> 456 return F.conv2d(input, weight, bias, self.stride,
457                     self.padding, self.dilation, self.groups)

```

KeyboardInterrupt:

```

[ ]: # Plot loss and gradient magnitudes
plt.plot(losses, label='Loss')
plt.plot(grad_magnitudes, label='Gradient Magnitudes')
plt.xlabel('Epoch')
plt.ylabel('Value')
plt.legend()
plt.show()

```

```

[ ]: labels_path = '/Users/Limit/imagenet_annot/validation_set_labels.csv'

labels_df = pd.read_csv(labels_path)

labels_df_leq_20 = labels_df[labels_df['label'] <= 20]

labels_validation_images = labels_df_leq_20['label'].tolist()

```

```

[ ]: len(labels_df_leq_20['ImageId'].tolist())
model.eval()

```

```

[ ]: image_path = "/Users/Limit/imagenet-object-localization-challenge_validation/
    ↪val"
filenames_image_path = []
for root, _, filenames in os.walk(image_path):
    for i in filenames:
        #         print(i)
        if (i.split('.')[0] in labels_df_leq_20['ImageId'].tolist()):
            filenames_image_path.append(i)
true_label = 0
counter = 0
correct_labels = 0
start_time = time.time()
grab_980_max_val = []
for i in range(len(filenames_image_path)):
    counter +=1
    #         print(i)
    #         print(counter)
    image_name = image_path + '/' + filenames_image_path[i]
    # black and white
    #         image_name = "/Users/Limit/imagenet-object-localization-challenge/
    ↪n01440764/n01440764_15560.JPEG"
    input_image = Image.open(image_name)

    input_tensor = preprocess(input_image)
    input_batch = input_tensor.unsqueeze(0) # create a mini-batch as expected ↪
    ↪by the model

    # move the input and model to GPU for speed if available
    if torch.cuda.is_available():
        input_batch = input_batch.to('cuda')
        model.to('cuda')

    if (counter%100 == 0):
        print("currently at", counter, 'current time is', time.time() - ↪
    ↪start_time)
        with torch.no_grad():
            output = model(input_batch)
            # Tensor of shape 1000, with confidence scores over ImageNet's 1000 classes
            #         if (torch.argmax(output[0]).item() == true_label):
            #             correct_labels += 1
            ↪
    ↪print('*****')
    print('Predicting Test Sample', counter, ':   Prediction is Correct?')
    if (torch.argmax(output[0]).item() == labels_validation_images[i]):
        print('Yes')

```



```

        correct_labels += 1
    else:
        print('No')
    prob_softmax = torch.softmax(output[0], dim = 0)
    print("first 20 classes probability:", prob_softmax[:20])
    print()
    print('max probability is', torch.max(prob_softmax, dim = 0))
    print()
    print('the max probability of the rest of 980 dim is')
    print(torch.topk(prob_softmax[20:], k=4))
    ↵
    ↵print('End*****')
    print()

    grab_980_max_val.append(torch.topk(prob_softmax[20:], k=4)[1][1:])
    # The output has unnormalized scores. To get probabilities, you can run a ↵
    ↵softmax on it.
    probabilities = torch.nn.functional.softmax(output[0], dim=0)
    # print(probabilities)

print('the overall testing error is')
print(correct_labels/counter)

```

```
[ ]: sum(grab_980_max_val)/counter
```

```
[ ]: counter
```

```
[ ]: # OLD code

# model_alex_given.eval()

# for i in range(40):
#     input_batch = input_tensor[i].unsqueeze(0) # create a mini-batch as ↵
#     ↵expected by the model

#     prediction = model_alex_given(input_batch)
#     print('prediction:')
#     print(torch.argmax(prediction))
#     print("answer:")
#     print(labels_numerical[i])
#     print()

```

```
[ ]: torch.save(model.state_dict(), 'model_weights_alexnet_temp_temp_temp.pth')
```

```
[ ]: # filenames_image_path
```