Deep Model Training

IPEO Exercise 8

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Welcome to Pytorch Exercises 8

In three exercises, we will focus on
Deep Learning with Pytorch

IPEO exercise 6	Introduction to Pytorch with Logistic Regression
IPEO exercise 7	Image Classification with CNNs
IPEO exercise 8	**Model Training and Regularization**
IPEO exercise 9	Semantic Segmentation

We require GPUs for model training

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SCITAS
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check `scitas_instructions.pdf`

Google Colaboratory

check `setup_gpus.pdf`

you can check if you have a GPU environment with `nvidia-smi`

```
Fri Oct 21 11:30:56 2022
+-----------------------------------------------------------------------------+
| NVIDIA-SMI 460.32.03    Driver Version: 460.32.03    CUDA Version: 11.2     |
|-------------------------------+----------------------+----------------------+
| GPU  Name        Persistence-M| Bus-Id        Disp.A | Volatile Uncorr. ECC |
| Fan  Temp  Perf  Pwr:Usage/Cap|         Memory-Usage | GPU-Util  Compute M. |
|                               |                      |               MIG M. |
|===============================+======================+======================|
|   0  Tesla T4            Off  | 00000000:00:04.0 Off |                    0 |
| N/A   43C    P8     9W /  70W |      3MiB / 15109MiB |      0%      Default |
|                               |                      |                  N/A |
+-------------------------------+----------------------+----------------------+
```

Moving tensors and models to GPU

```
device = "cuda" # or "cpu"

tensor = tensor.to(device)
model = model.to(device)

# back to cpu
tensor.cpu() # or .to("cpu")
```

$> 10\times$ speedup with GPUs

In [19]:
```
print("cuda")
%timeit training_step(batch, model, optimizer, device="cuda")

print("cpu")
%timeit training_step(batch, model, optimizer, device="cpu")
```

```
cuda
77.1 ms ± 337 µs per loop (mean ± std. dev. of 7 runs, 10 loops each)
cpu
823 ms ± 19.1 ms per loop (mean ± std. dev. of 7 runs, 1 loop each)
```

Training Loop

setup before each epoch

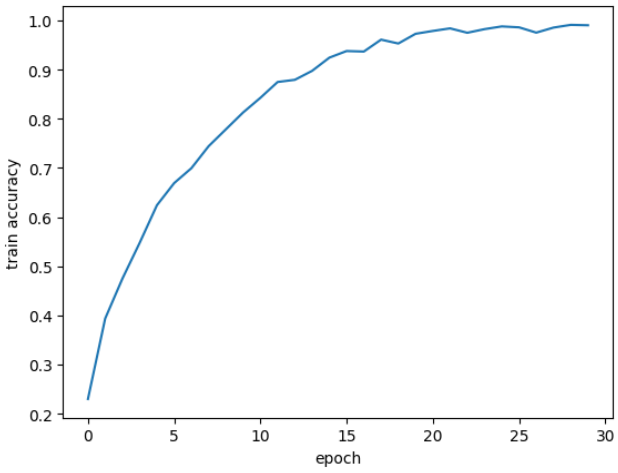
```
#require
model
dataloader
optimizer

# set model to training mode
model.train()

# cuda means GPU
device = "cuda"

# move model to GPU
model = model.to(device)
```

training step

```
# training step
for batch in dataloader:
  optimizer.zero_grad()

  x, y = batch

  # move data to GPU
  x = x.to(device)
  y = y.to(device)

  # predict
  y_logit = model(x)

  # calculate the loss
  loss = criterion(y_logit, y)

  # backpropoagation
  loss.backward()
```

Training Output

```
epoch 0; trainloss 2.48, train accuracy 28.35%
epoch 1; trainloss 1.88, train accuracy 39.24%
epoch 2; trainloss 1.59, train accuracy 49.29%
epoch 3; trainloss 1.36, train accuracy 57.59%
epoch 4; trainloss 1.18, train accuracy 63.16%
epoch 5; trainloss 1.05, train accuracy 68.80%
epoch 6; trainloss 0.90, train accuracy 73.07%
epoch 7; trainloss 0.85, train accuracy 73.31%
epoch 8; trainloss 0.72, train accuracy 78.85%
epoch 9; trainloss 0.62, train accuracy 82.54%
epoch 10; trainloss 0.56, train accuracy 84.23%
epoch 11; trainloss 0.51, train accuracy 85.02%
epoch 12; trainloss 0.48, train accuracy 86.47%
epoch 13; trainloss 0.42, train accuracy 88.21%
epoch 14; trainloss 0.33, train accuracy 91.90%
epoch 15; trainloss 0.29, train accuracy 93.67%
epoch 16; trainloss 0.26, train accuracy 93.41%
epoch 17; trainloss 0.21, train accuracy 95.33%
epoch 18; trainloss 0.16, train accuracy 96.84%
epoch 19; trainloss 0.16, train accuracy 97.02%
epoch 20; trainloss 0.13, train accuracy 97.39%
epoch 21; trainloss 0.15, train accuracy 96.97%
epoch 22; trainloss 0.13, train accuracy 97.31%
epoch 23; trainloss 0.10, train accuracy 98.39%
epoch 24; trainloss 0.10, train accuracy 98.42%
epoch 25; trainloss 0.08, train accuracy 98.89%
epoch 26; trainloss 0.09, train accuracy 98.02%
epoch 27; trainloss 0.09, train accuracy 98.47%
epoch 28; trainloss 0.05, train accuracy 99.53%
epoch 29; trainloss 0.05, train accuracy 99.45%
```



30% worse validation accuracy!

```
valloss 1.43, val accuracy 66.59
```

Regularization to the rescue

- change the model architecture (check out other torchvision models)
- start from pre-trained weight initializations
- introduce weight_decay to the optimizer
- change the optimizer (e.g. to Adam)
- do data augmentation (see last exercise)

Exercise Outline

1. load UC Merced dataset module (provided in the moodle)
2. load a ResNet18 model from torchvision.models
3. train the model on the training set
4. test on the validation set
5. fight overfitting with regularization and earn your cookies

Open Challenge until next Week

We added a pytorch lighting code at the end to train models efficiently with few lines of code.

until next week implement different regularizations and post your result in slack.

- test accuracy $>$ 80%, we will bring one cookie bag
- test accuracy $>$ 85%, we will bring two cookie bags
- test accuracy $>$ 90%, we will bring three cookie bags
- test accuracy $>$ 95%, we won´t believe you

Importing objects from other script

Structuring your code in multiple files is good practice to keep your code clean.

- `UCMerced_module.py`
  - class UCMerced(Dataset)
  - def function ...
  - variable = ”something”
- `notebook.ipynb` (or `main.py`)
  - from UCMerced_module import UCMerced