Lab Tutorial: TACC Platform

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COMP 4901Y

TACC Brief

- What is TACC[1]?
  - An efficient cluster management solution for machine learning applications in large-scale GPU clusters
- What is the TACC cluster?
  - A server cluster with hundreds of GPUs operated via TACC
- How users share the TACC cluster to run various machine learning tasks?
  - Users submit their job description via tcloud [2]
  - TACC compiles the job description and generate a running environment
  - TACC schedules worker nodes for job executing and return results.

[1] https://tacc.ust.hk/
[2] https://github.com/turingaicloud/quickstart

TACC Brief

- What is TACC[1]?
  - An efficient cluster management solution for machine learning applications in large-scale GPU clusters

Task in this Lab: Complete HW2 Q3 via TACC

- How users share the TACC cluster to run various machine learning tasks?
  - Users submit their job description via tcloud [2]
  - TACC compiles the job description and generate a running environment
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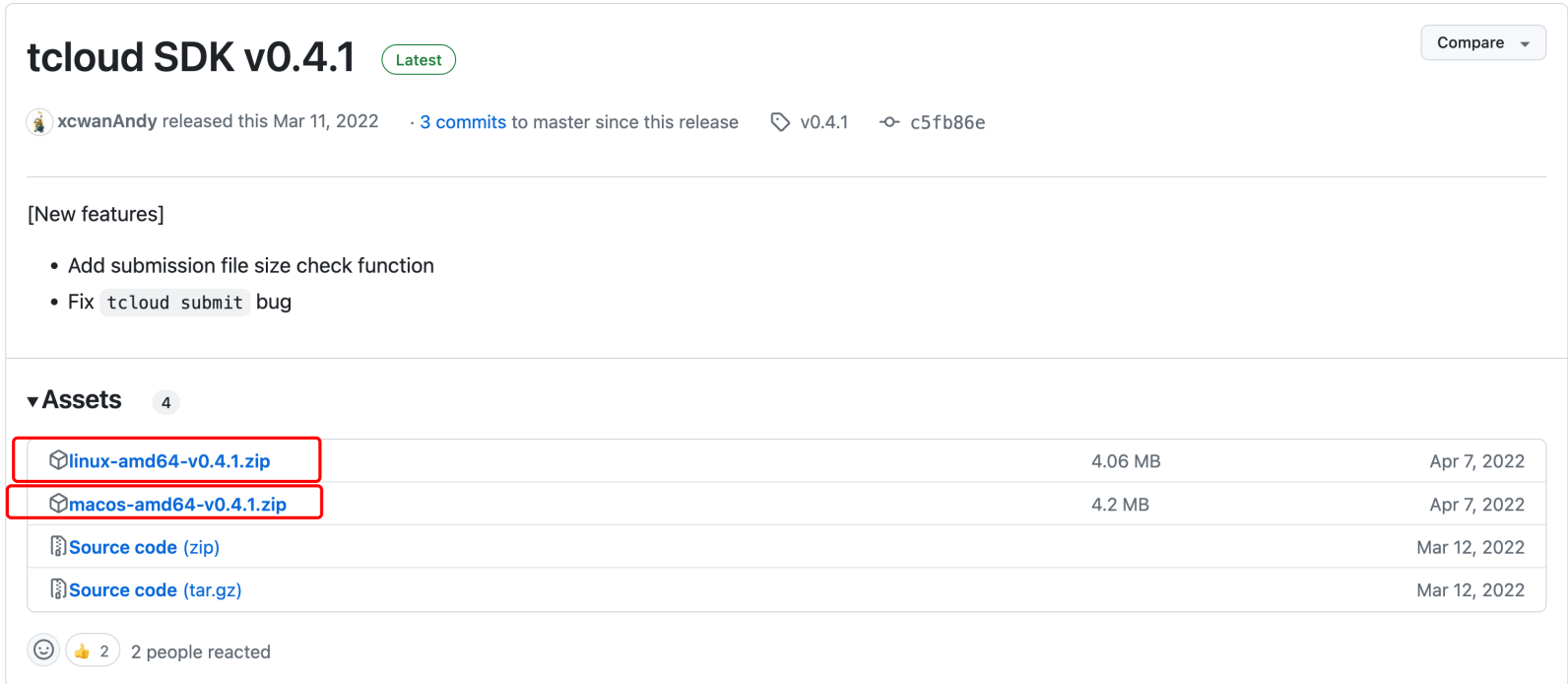
TACC Quick Start

- **Apply for access**
  - Link: https://tacc.ust.hk/#hkust
  - Click "Apply for access" and submit your application

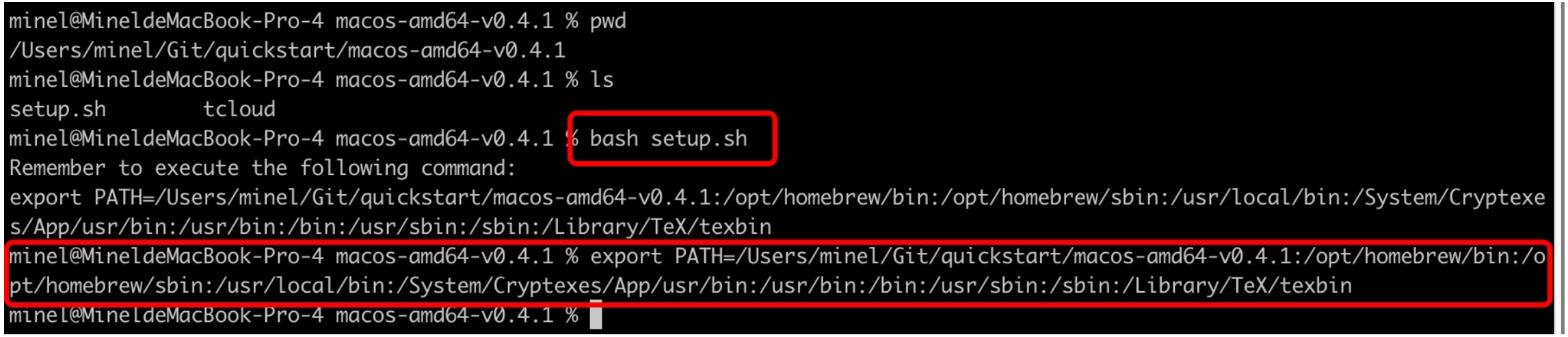
TACC Quick Start

- **Prepare local running environment**
  - **Step 1**: download *tcloud* to your own laptop/computer
    - Download *tcloud* from [github page]
    - Currently, *tcloud* only supports MacOS and Linux OS. If your OS is Windows, please try to install a virtual environment for Ubuntu.



TACC Quick Start

- **Prepare local running environment**
  - **Step 2**: Decompress and setup tcloud environment
    - cd to the path of *tcloud*, and run the setup.sh
    - The setup.sh will output an environmental path, which looks like: "export PATH=/....." . Copy this command to the terminal and run.



TACC Quick Start

- **Prepare local running environment**
  - **Step 2**: Decompress and setup tcloud environment
    - If successful, run the "tcloud" at your terminal, then it will output:

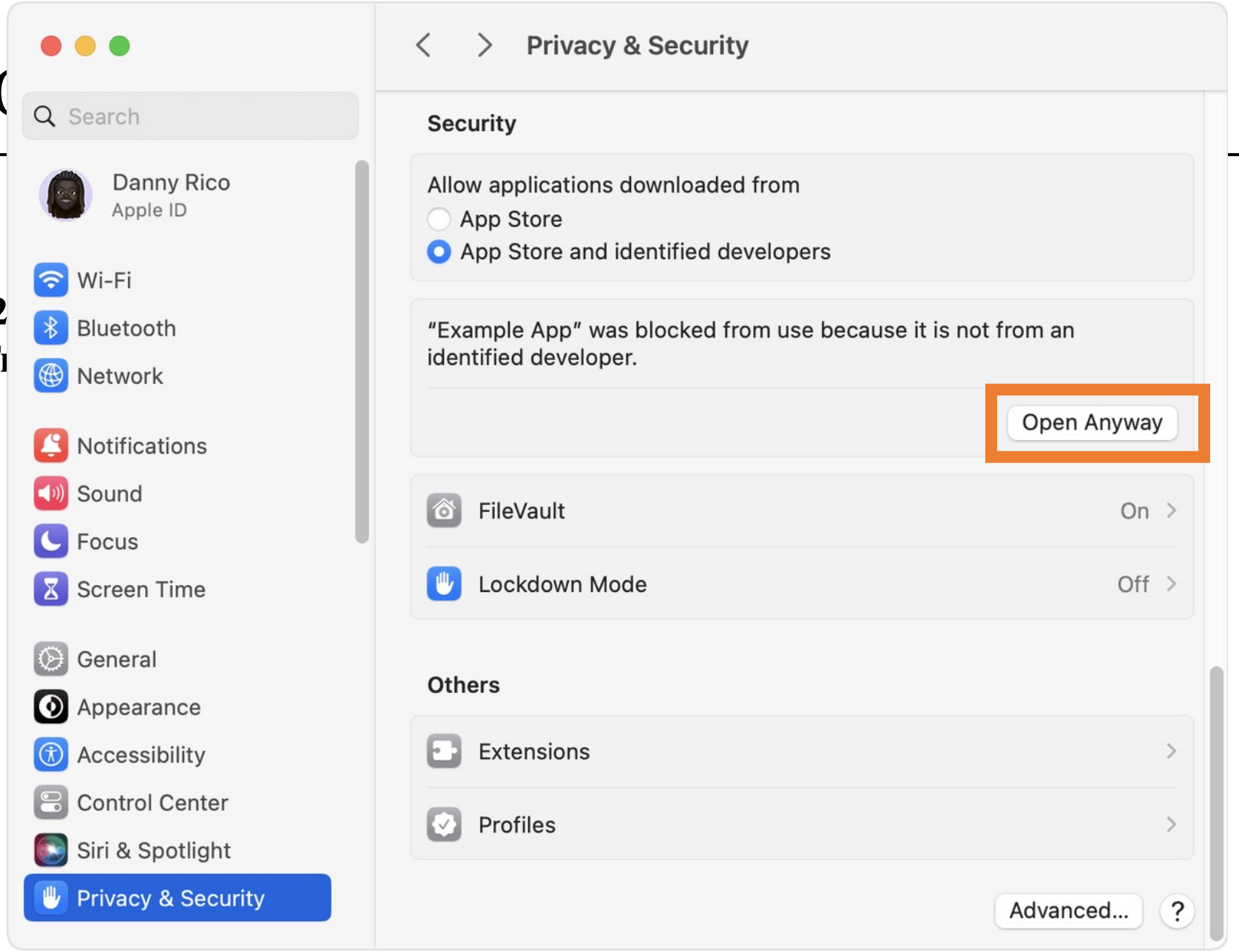
```
minel@MineldeMBP-4 macos-amd64-v0.4.1 % tcloud
TACC Command-line Interface 0.4.1

Usage:
  tcloud [command]

Available Commands:
  add         Add dependency to tuxiv.conf file
  cancel      Cancel job
  cat         Concatenate FILE(s) to standard output.
  config      Configure user's account in tcloud CLI
  download    Download file from TACC
  env         Check environment
```

TACC Quick Start

- **Prepare local running environment**
  - **Step 2**: Decompress and setup tcloud environment
    - **Troublesome**
    - For MacOS users, the OS may warn that "The developer cannot be verified.....". To solve it:
      - Open the "Privacy & Security" in the system configuration
      - Find "tcloud was blocked from use...", click open anyway

TACC C

- **Prepare**
  - **Step 2**
    - **Tr**



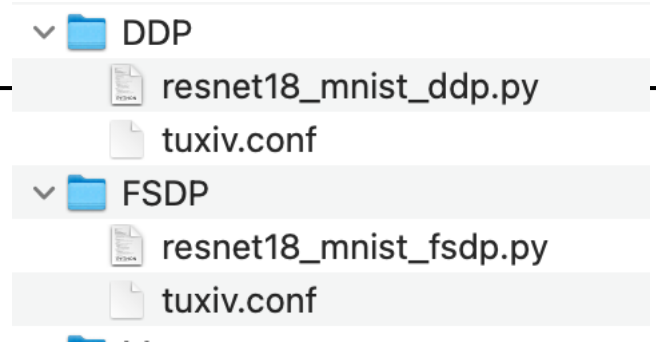
TACC Quick Start

- **Prepare local running environment**
  - **Step 3**: *tcloud* initialization
    - First, you need to configure your TACC credentials. You can do this by running the tcloud config command:
      - $ tcloud config [-u/--username] MYUSERNAME
      - $ tcloud config [-f/--file] MYPRIVATEFILEPATH
    - Then, run tcloud init to obtain the latest cluster hardware information from TACC cluster.

```
Bash ▾                                                    自动换行 | 复制
1 PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
2 tacc*        up   infinite      5  alloc 10-0-7-[18-19],10-0-8-[18-19]
3 tacc*        up   infinite     19   idle 10-0-2-[18-19],10-0-3-[10-13]
```

    - If you get a similar output above, congratulations on having completed all the initialization processes

Submit Your First Job



- **Download <u>sample codes</u> and <u>job description</u>**
  - A python program that you want to execute
  - A configuration file for descripting your job
    - Do not change any entries in tuxiv.conf for your first submission!

- **Submit your job via tcloud**
  - cd to the "DDP" folder, and run tcloud submit
  - The tcloud will generate a transaction to the TACC cluster

```
minel@MineldeMacBook-Pro-4 DDP % ls
resnet18_mnist_ddp.py   tuxiv.conf
minel@MineldeMacBook-Pro-4 DDP % tcloud submit
Start parsing tuxiv.conf...
building file list ...
8 files to consider
DDP/
DDP/run.sh
```

Submit Your First Job

- **Example outputs for your first submission**
  - For the first time, TACC needs to generate your running environment
  - The step may need around 15 minutes, just for the first time

```
minel@MineldeMacBook-Pro-4 DDP % tcloud submit
Start parsing tuxiv.conf...
building file list ...
8 files to consider
DDP/
DDP/run.sh
         236 100%    0.00kB/s    0:00:00 (xfer#1, to-check=5/8)
DDP/configurations/
DDP/configurations/citynet.sh
           0 100%    0.00kB/s    0:00:00 (xfer#2, to-check=2/8)
DDP/configurations/conda.yaml
         169 100%  165.04kB/s    0:00:00 (xfer#3, to-check=1/8)
DDP/configurations/run.slurm
         309 100%  301.76kB/s    0:00:00 (xfer#4, to-check=0/8)
```

```
sent 441 bytes  received 138 bytes  386.00 bytes/sec
total size is 7663  speedup is 13.23
Channels:
 - pytorch
 - nvidia
 - defaults
Platform: linux-64
Collecting package metadata (repodata.json): done
Solving environment: done

Downloading and Extracting Packages:

Preparing transaction: done
Verifying transaction: done
Executing transaction: /
```

Submit Your First Job

- **Example outputs for your first submission**
  - Next, tcloud will return a Job ID for the submission
  - Run tcloud ps to check the job status

```
done
#
# To activate this environment, use
#
#     $ conda activate comp4901y-hw2
#
# To deactivate an active environment, use
#
#     $ conda deactivate

Env comp4901y-hw2 exists, dependencies updated.
Submitted batch job 22894
Job DDP submitted.
minel@MineldeMacBook-Pro-4 DDP %
```

```
eMacBook-Pro-4 DDP % tcloud ps
 JOBID PARTITION     NAME     USER ST       TIME  NODES NODELIST(REASON)
 22894      tacc run.slur  xinyang  R       0:19      1 10-0-1-18
```

Submit Your First Job

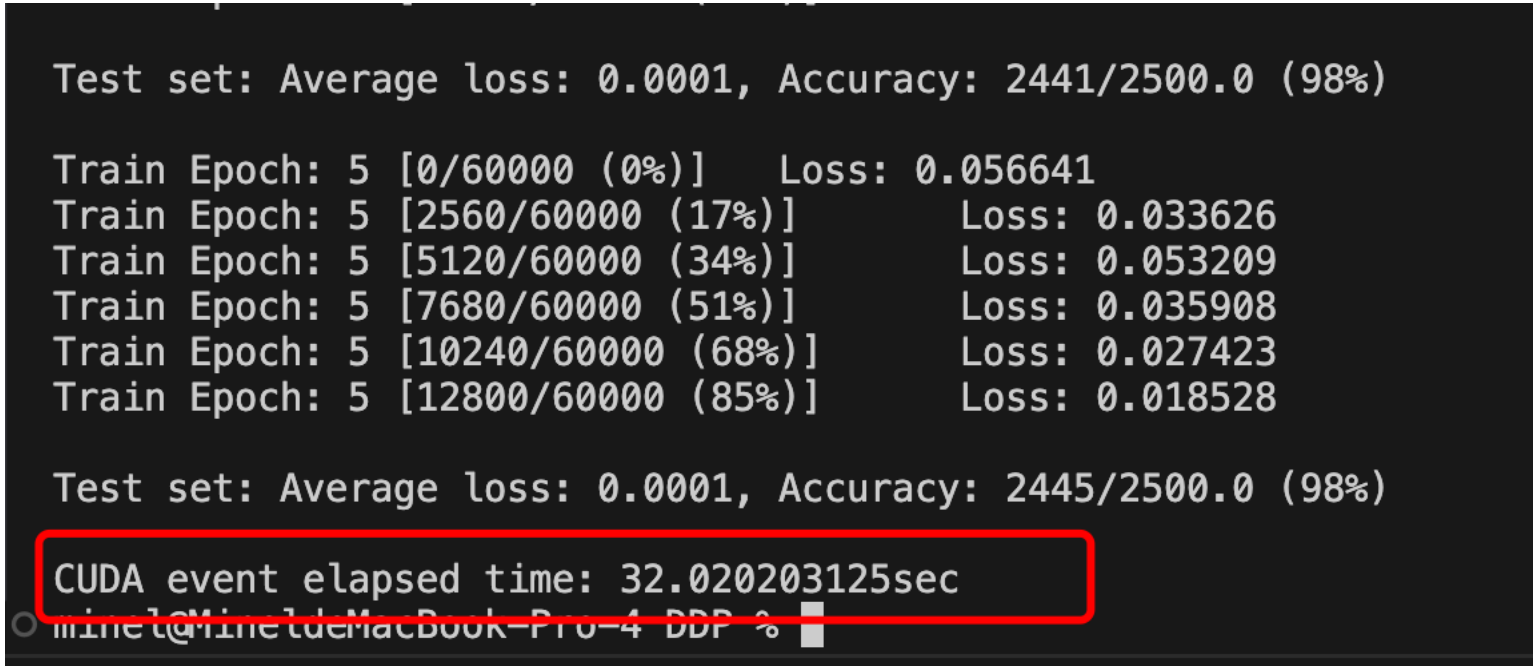
- **Get outputs for your submission**
  - Run tcloud cat slurm_log/slurm-<Your Job ID>.out

```
minel@MineldeMacBook-Pro-4 DDP % tcloud cat slurm_log/slurm-22894.out
Train Epoch: 1 [0/60000 (0%)]   Loss: 2.487836
Train Epoch: 1 [2560/60000 (17%)]       Loss: 0.724260
Train Epoch: 1 [5120/60000 (34%)]       Loss: 0.467392
Train Epoch: 1 [7680/60000 (51%)]       Loss: 0.350130
Train Epoch: 1 [10240/60000 (68%)]      Loss: 0.188361
Train Epoch: 1 [12800/60000 (85%)]      Loss: 0.136022

Test set: Average loss: 0.0002, Accuracy: 2381/2500.0 (95%)

Train Epoch: 2 [0/60000 (0%)]   Loss: 0.147818
Train Epoch: 2 [2560/60000 (17%)]       Loss: 0.109058
Train Epoch: 2 [5120/60000 (34%)]       Loss: 0.168625
Train Epoch: 2 [7680/60000 (51%)]       Loss: 0.131864
Train Epoch: 2 [10240/60000 (68%)]      Loss: 0.073659
Train Epoch: 2 [12800/60000 (85%)]      Loss: 0.060909

Test set: Average loss: 0.0001, Accuracy: 2417/2500.0 (97%)

Train Epoch: 3 [0/60000 (0%)]   Loss: 0.094916
```

  - Run tcloud ls slurm_log if you forget your job id

Submit DDP & FSDP codes for HW Q3

- **Check the CUDA elapsed time to record the training duration**



Submit DDP & FSDP codes for HW Q3

- **Change the tuxiv.conf for different parallelisms**
  - ntasks-per-node: the number of tasks for the job, each task will occupy one GPU

```
entrypoint:
  - CUDA_VISIBLE_DEVICES="0,1,2,3" python ${TACC_WORKDIR}/resnet18_mnist_fsdp.py --datasetDir=/mnt/data/mnist --batch-size=256
  --epoch=5
environment:
    name: comp4901y-hw2
    channels:
      - pytorch
      - nvidia
    dependencies:
      - python=3.11
      - pytorch=2.1.1
      - torchvision=0.16.1
      - torchaudio=2.1.1
      - cudatoolkit=11.8.0
job:
    name: resnet18_mnist_fsdp
    general:
      - nodes=1
      - ntasks-per-node=4
      - cpus-per-task=1
      - gres=gpu:4
```

Change from one to four

Submit DDP & FSDP codes for HW Q3

- **Record the training duration for different parallelisms**
  - Reference duration for DDP
    - 67.7970, 47.3447, 36.9281, 30.4318
  - Reference duration for FSDP
    - 72.1242, 60.0969, 42.9850, 35.6776

Office Hour for Q&A: TBD
Room 3661, Academic Building

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