Lab Tutorial: TACC Platform

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COMP 4901Y

2025 Spring

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
  - TACC schedules worker nodes for job executing and return results

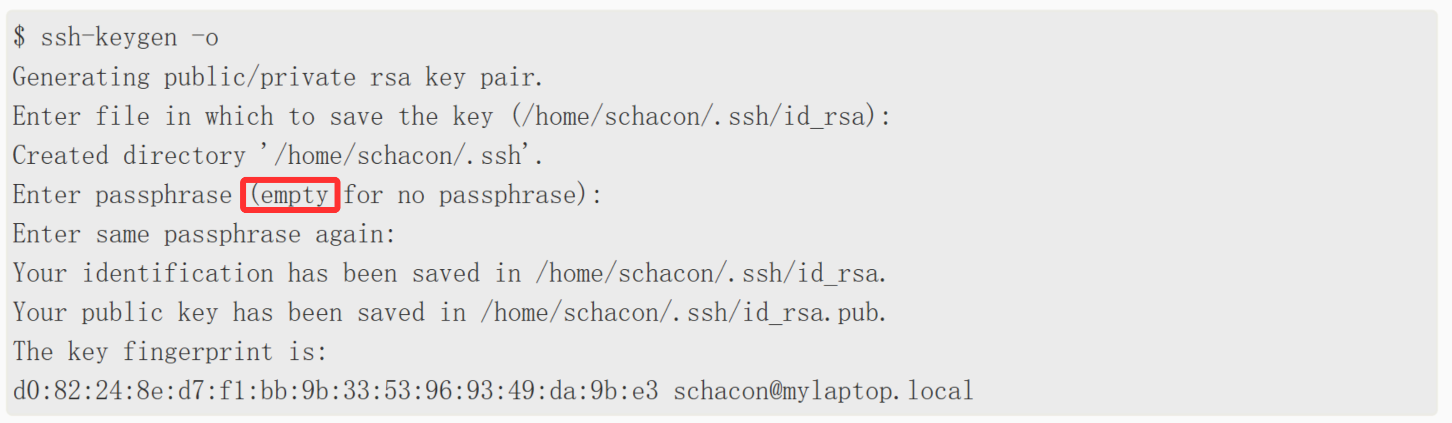
[1] https://tacc.ust.hk/
[2] https://github.com/turingaicloud/quickstart

TACC Quick Start

- Apply for access
  - Link: https://tacc.ust.hk/#hkust
  - Click "Apply for access” and submit your application
  - Please mention "COMP4901Y" when describing your intended use case of TACC

TACC Quick Start

- **Cautions**
  - When generating your SSH public key
    - Do not set a passphrase for your key (i.e. just press "Enter" at this step)
    - Do not generate a new SSH key if you already have one, or you will lose access to all platforms associated with your old SSH key.

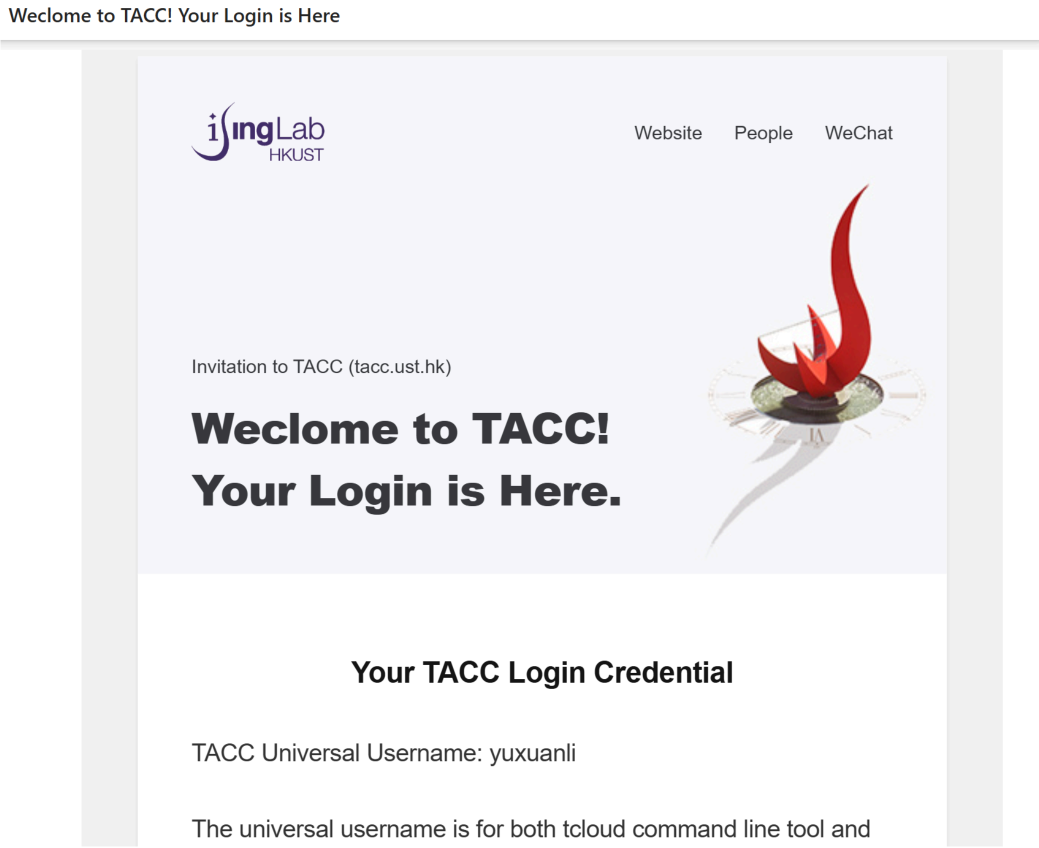


```
$ ssh-keygen -o
Generating public/private rsa key pair.
Enter file in which to save the key (/home/schacon/.ssh/id_rsa):
Created directory '/home/schacon/.ssh'.
Enter passphrase (empty for no passphrase):
Enter same passphrase again:
Your identification has been saved in /home/schacon/.ssh/id_rsa.
Your public key has been saved in /home/schacon/.ssh/id_rsa.pub.
The key fingerprint is:
d0:82:24:8e:d7:f1:bb:9b:33:53:96:93:49:da:9b:e3 schacon@mylaptop.local
```

  - Please make sure to apply for access in advance and **start your experiments early** to avoid potential queueing delays.

TACC Quick Start

- Successful registration
  - A login credential email will be sent if your registration is approved



Weclome to TACC! Your Login is Here

Invitation to TACC (tacc.ust.hk)

Weclome to TACC!
Your Login is Here.

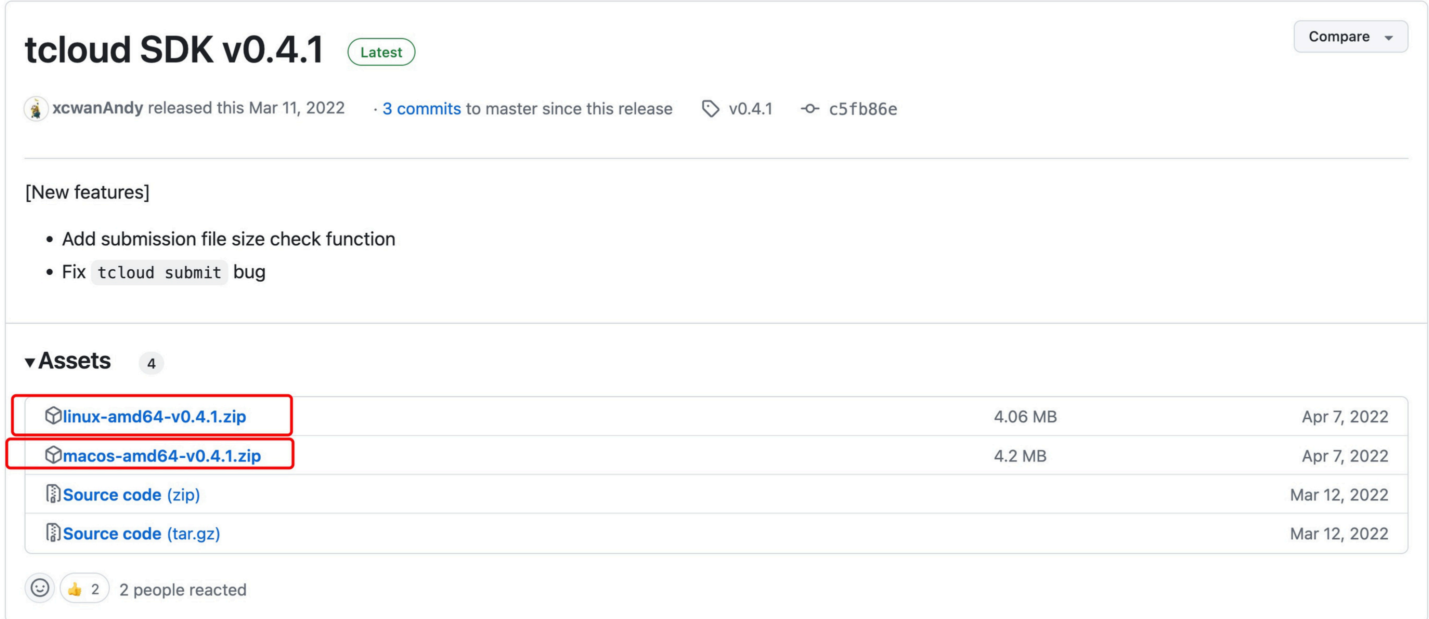
Your TACC Login Credential

TACC Universal Username: yuxuanli

The universal username is for both tcloud command line tool and

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.



tcloud SDK v0.4.1

xcwanAndy released this Mar 11, 2022 · 3 commits to master since this release v0.4.1 c5fb86e

[New features]

- Add submission file size check function
- Fix `tcloud submit` bug

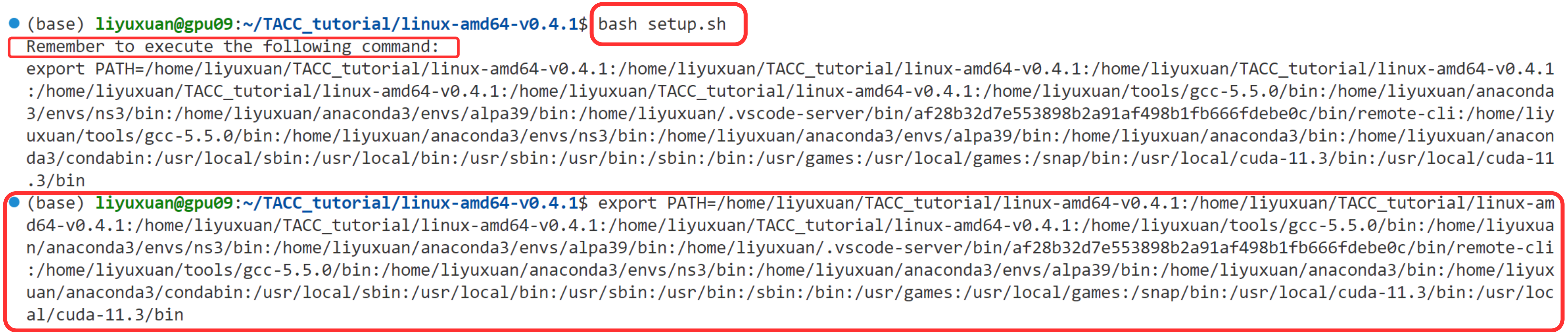
Assets 4

linux-amd64-v0.4.1.zip	4.06 MB	Apr 7, 2022
macos-amd64-v0.4.1.zip	4.2 MB	Apr 7, 2022
Source code (zip)		Mar 12, 2022
Source code (tar.gz)		Mar 12, 2022

2 2 people reacted

TACC Quick Start

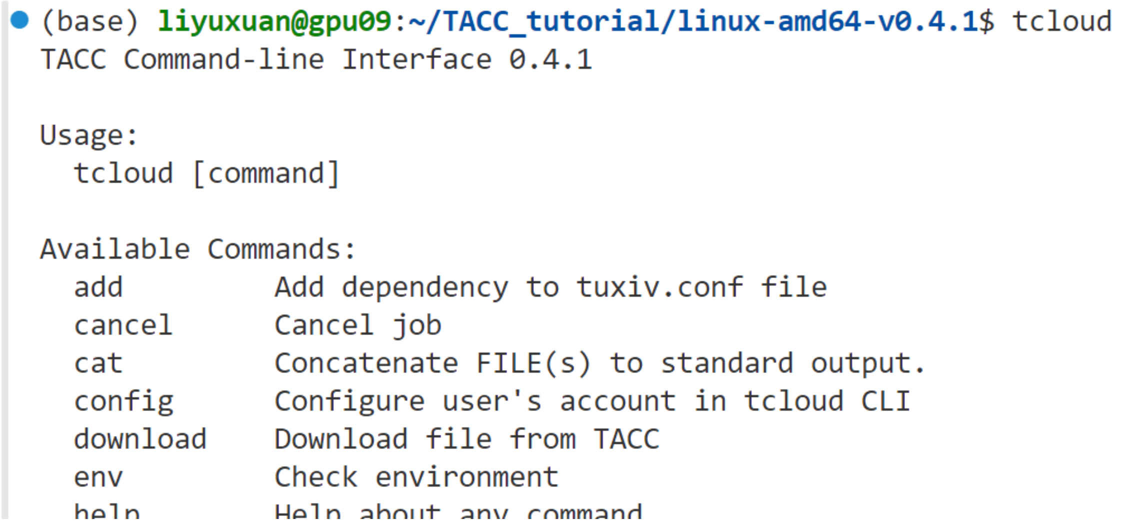
- **Prepare local running environment**
  - **Step 2**: Decompress and setup tcloud environment
    - cd to the path of *tcloud*, and run the setup.sh
    - The setup.sh will output an environmental path, which looks like: "export PATH=/......". Copy this command to the terminal and run.



```
● (base) liyuxuan@gpu09:~/TACC_tutorial/linux-amd64-v0.4.1$ bash setup.sh
  Remember to execute the following command:
  export PATH=/home/liyuxuan/TACC_tutorial/linux-amd64-v0.4.1:/home/liyuxuan/TACC_tutorial/linux-amd64-v0.4.1:/home/liyuxuan/TACC_tutorial/linux-amd64-v0.4.1
  :/home/liyuxuan/TACC_tutorial/linux-amd64-v0.4.1:/home/liyuxuan/TACC_tutorial/linux-amd64-v0.4.1:/home/liyuxuan/tools/gcc-5.5.0/bin:/home/liyuxuan/anaconda
  3/envs/ns3/bin:/home/liyuxuan/anaconda3/envs/alpa39/bin:/home/liyuxuan/.vscode-server/bin/af28b32d7e553898b2a91af498b1fb666fdebe0c/bin/remote-cli:/home/liy
  uxuan/tools/gcc-5.5.0/bin:/home/liyuxuan/anaconda3/envs/ns3/bin:/home/liyuxuan/anaconda3/envs/alpa39/bin:/home/liyuxuan/anaconda3/bin:/home/liyuxuan/anacon
  da3/condabin:/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/games:/usr/local/games:/snap/bin:/usr/local/cuda-11.3/bin:/usr/local/cuda-11
  .3/bin
● (base) liyuxuan@gpu09:~/TACC_tutorial/linux-amd64-v0.4.1$ export PATH=/home/liyuxuan/TACC_tutorial/linux-amd64-v0.4.1:/home/liyuxuan/TACC_tutorial/linux-am
  d64-v0.4.1:/home/liyuxuan/TACC_tutorial/linux-amd64-v0.4.1:/home/liyuxuan/TACC_tutorial/linux-amd64-v0.4.1:/home/liyuxuan/tools/gcc-5.5.0/bin:/home/liyuxua
  n/anaconda3/envs/ns3/bin:/home/liyuxuan/anaconda3/envs/alpa39/bin:/home/liyuxuan/.vscode-server/bin/af28b32d7e553898b2a91af498b1fb666fdebe0c/bin/remote-cli
  :/home/liyuxuan/tools/gcc-5.5.0/bin:/home/liyuxuan/anaconda3/envs/ns3/bin:/home/liyuxuan/anaconda3/envs/alpa39/bin:/home/liyuxuan/anaconda3/bin:/home/liyux
  uan/anaconda3/condabin:/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/games:/usr/local/games:/snap/bin:/usr/local/cuda-11.3/bin:/usr/loc
  al/cuda-11.3/bin
```

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:



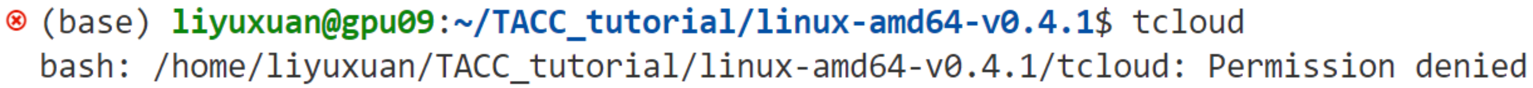
```
● (base) liyuxuan@gpu09:~/TACC_tutorial/linux-amd64-v0.4.1$ tcloud
  TACC Command-line Interface 0.4.1

  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
    help        Help about any command
```

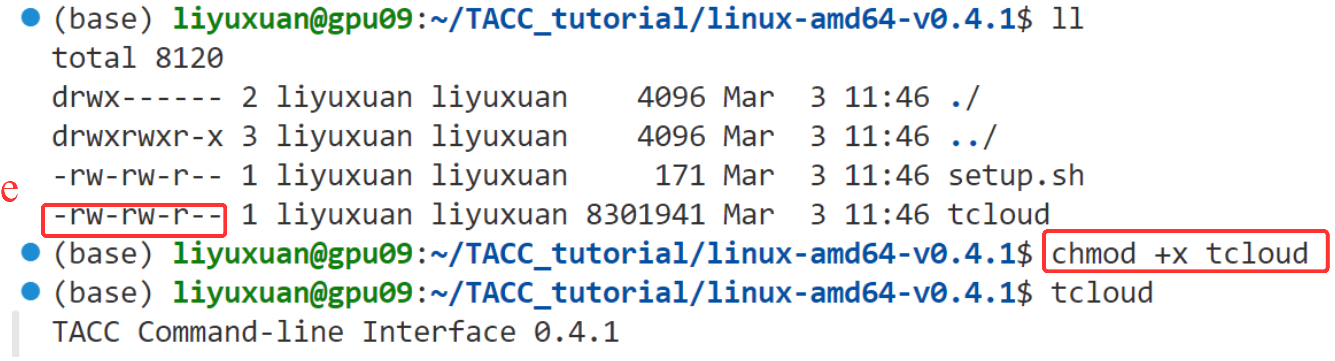
TACC Quick Start

- **Prepare local running environment**
  - **Step 2**: Decompress and setup tcloud environment
    - **Troublesome 1**



```
⊗ (base) liyuxuan@gpu09:~/TACC_tutorial/linux-amd64-v0.4.1$ tcloud
  bash: /home/liyuxuan/TACC_tutorial/linux-amd64-v0.4.1/tcloud: Permission denied
```

    - If met “Permission denied”. Please check:
      - Whether TACC application has been approved (i.e. have received Login Credential email)
      - Whether *tcloud* has an **execute** authorization. If not, run "chmod +x tcloud" to solve it



```
● (base) liyuxuan@gpu09:~/TACC_tutorial/linux-amd64-v0.4.1$ ll
  total 8120
  drwx------ 2 liyuxuan liyuxuan    4096 Mar  3 11:46 ./
  drwxrwxr-x 3 liyuxuan liyuxuan    4096 Mar  3 11:46 ../
  -rw-rw-r-- 1 liyuxuan liyuxuan     171 Mar  3 11:46 setup.sh
  -rw-rw-r-- 1 liyuxuan liyuxuan 8301941 Mar  3 11:46 tcloud
● (base) liyuxuan@gpu09:~/TACC_tutorial/linux-amd64-v0.4.1$ chmod +x tcloud
● (base) liyuxuan@gpu09:~/TACC_tutorial/linux-amd64-v0.4.1$ tcloud
  TACC Command-line Interface 0.4.1
```

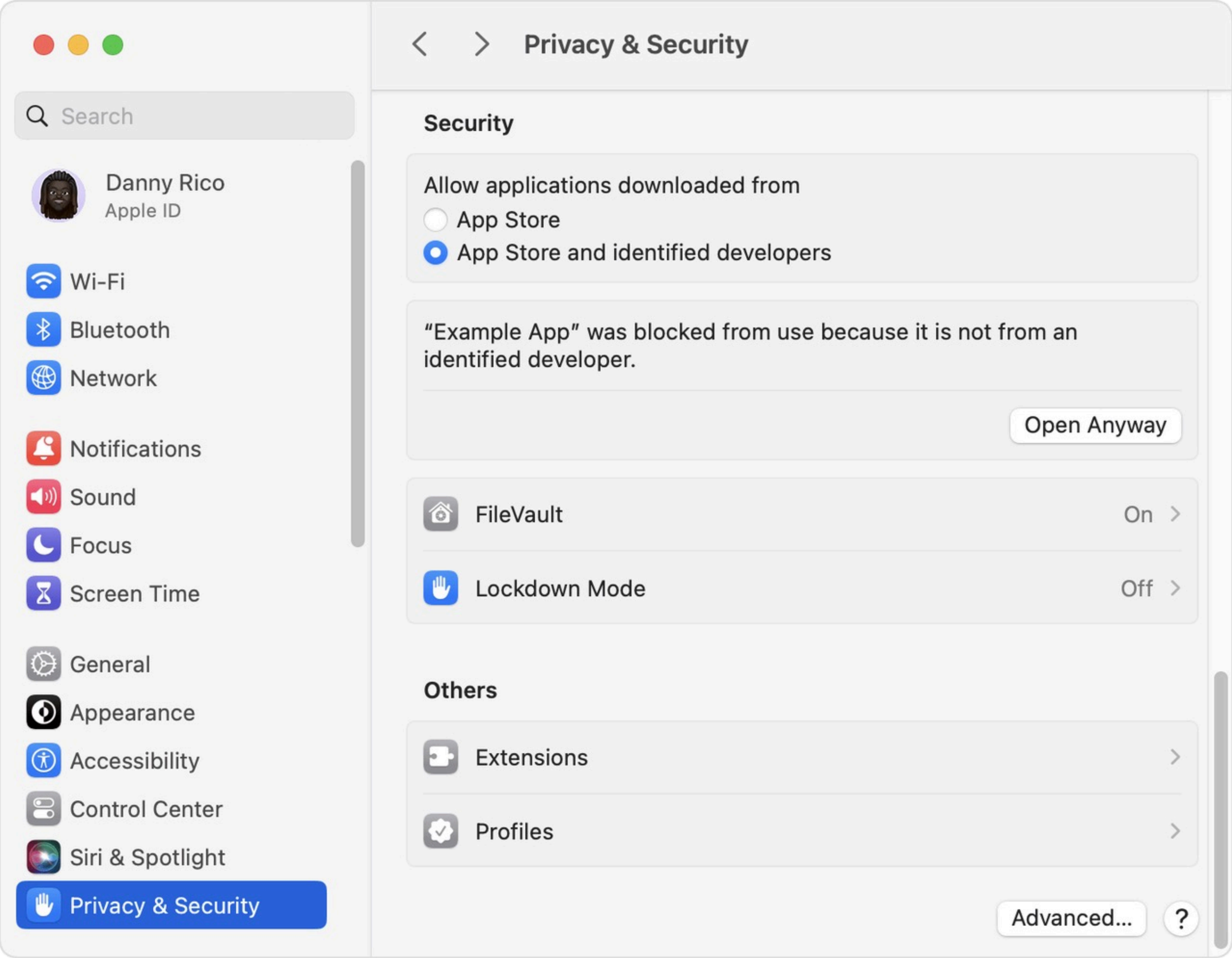
only read and write authorizations

TACC Quick Start

- **Prepare local running environment**
  - **Step 2**: Decompress and setup tcloud environment
    - **Troublesome 2**
    - 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

- **Prepare lo**
  - **Step 2**: D
    - **Troul**
    - For M … To solve it:
      - C
      - F



Privacy & Security

Security

Allow applications downloaded from

○ App Store

● App Store and identified developers

“Example App” was blocked from use because it is not from an identified developer.

Open Anyway

FileVault On

Lockdown Mode Off

Others

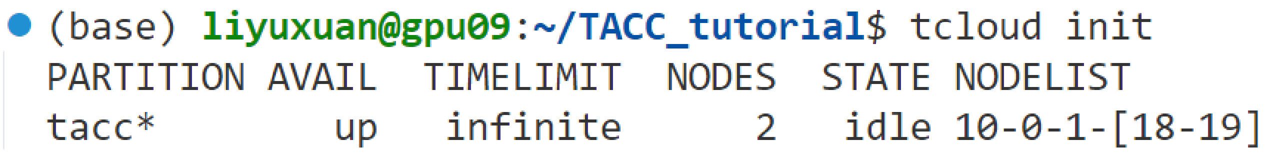
Extensions

Profiles

Advanced...

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
      - "config -f " is mainly for people who do not put private_key (id_rsa) in defualt directory /.ssh/
    - Then, run tcloud init to obtain the latest cluster hardware information from TACC cluster.

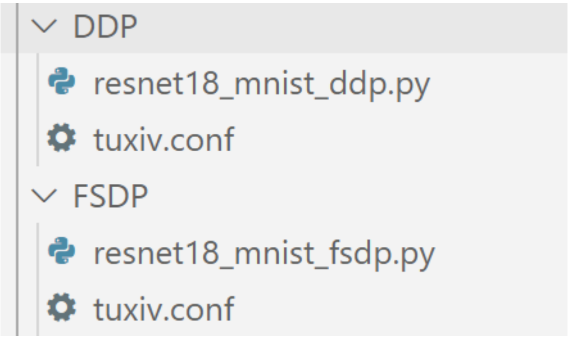


```
● (base) liyuxuan@gpu09:~/TACC_tutorial$ tcloud init
  PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
  tacc*        up   infinite      2   idle 10-0-1-[18-19]
```

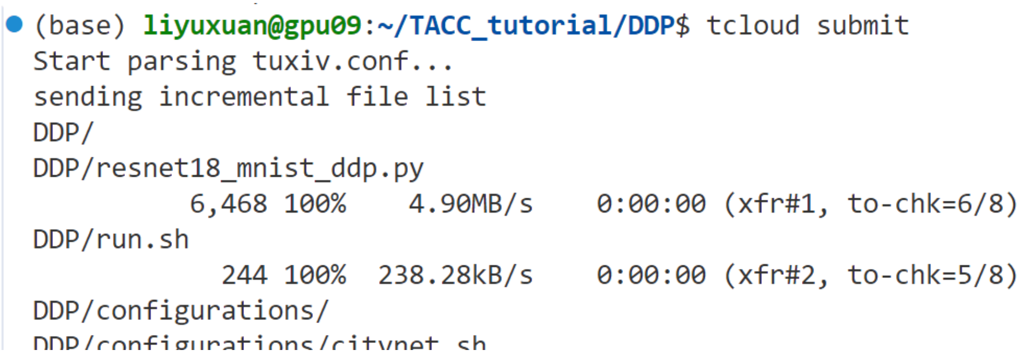
If you get a similar output above, congratulations on having completed all the initialization processes!

Submit Your First Job

- **Download sample codesand job description**
  - 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! (Except in the case of environment creation failure, which will be discussed on the next page.)
- **Submit your job via tcloud**
  - cd to the “DDP” folder, and run tcloud submit
  - The *tcloud* will generate a transaction to the TACC cluster



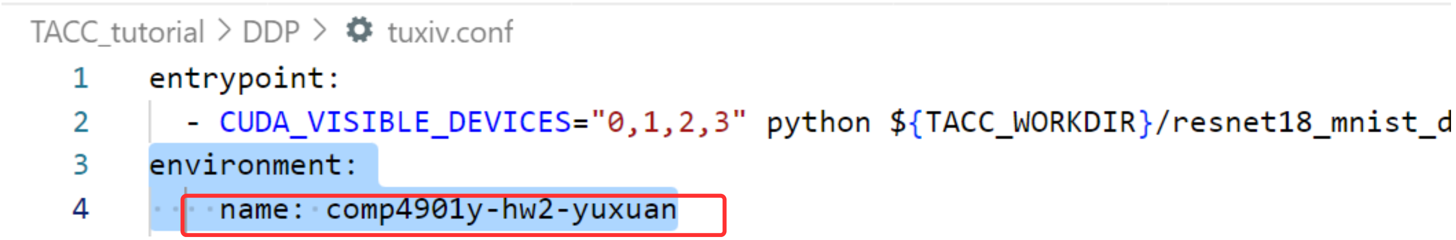
```
⌄ DDP
    resnet18_mnist_ddp.py
    tuxiv.conf
⌄ FSDP
    resnet18_mnist_fsdp.py
    tuxiv.conf
```



```
● (base) liyuxuan@gpu09:~/TACC_tutorial/DDP$ tcloud submit
  Start parsing tuxiv.conf...
  sending incremental file list
  DDP/
  DDP/resnet18_mnist_ddp.py
            6,468 100%    4.90MB/s    0:00:00 (xfr#1, to-chk=6/8)
  DDP/run.sh
              244 100%  238.28kB/s    0:00:00 (xfr#2, to-chk=5/8)
  DDP/configurations/
  DDP/configurations/citynet.sh
```

Submit Your First Job

- **Example outputs for your first submission**
  - For the first time, TACC needs to generate your running environment
    - If you create conda environment successfully, you can use it afterwards
    - If the conda environment creation **fails midway**, please rename the environment in tuxiv.conf; otherwise, conflicts may occur

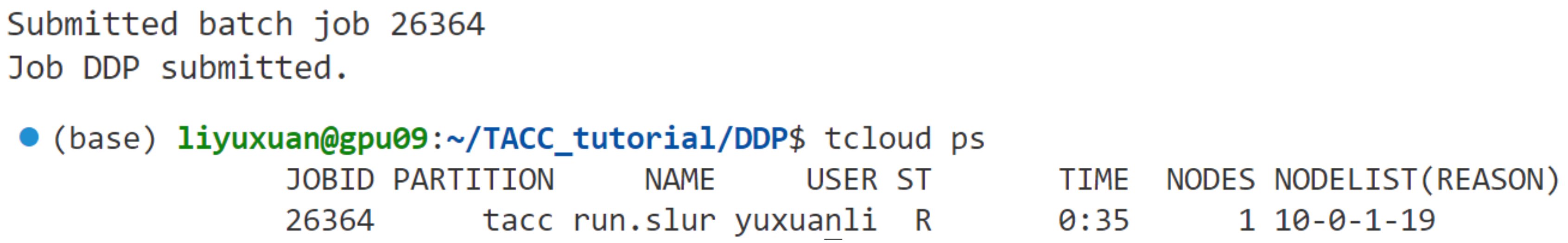


```
entrypoint:
  - CUDA_VISIBLE_DEVICES="0,1,2,3" python ${TACC_WORKDIR}/resnet18_mnist_d
environment:
    name: comp4901y-hw2-yuxuan
```

  - The step may need around 20 minutes, just for the first time

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

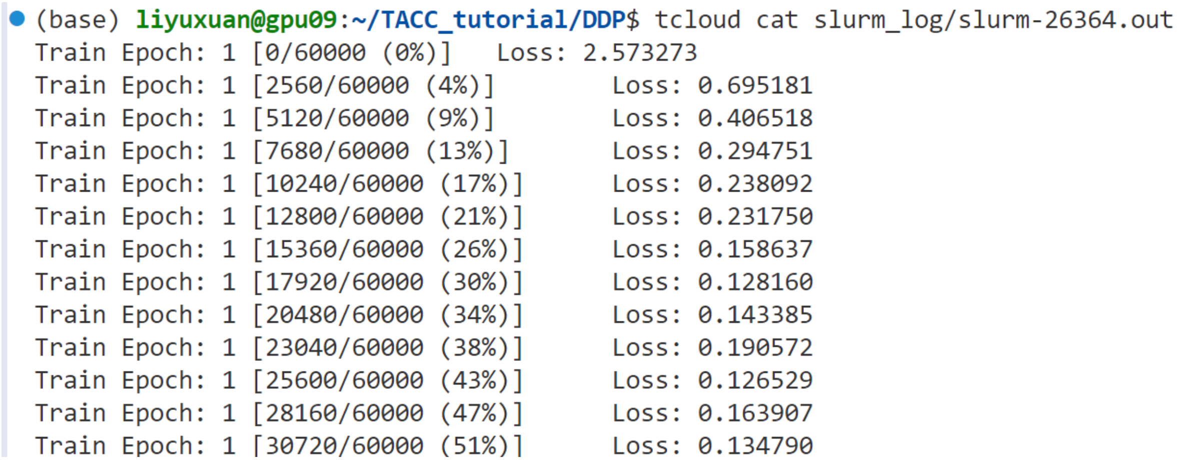


```
Submitted batch job 26364
Job DDP submitted.

● (base) liyuxuan@gpu09:~/TACC_tutorial/DDP$ tcloud ps
              JOBID PARTITION     NAME     USER ST       TIME  NODES NODELIST(REASON)
              26364      tacc run.slur yuxuanli  R       0:35      1 10-0-1-19
```

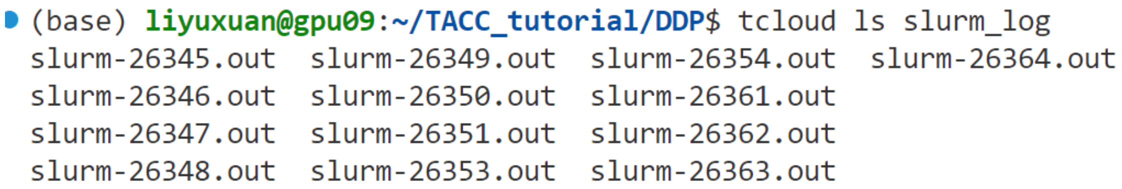
Submit Your First Job

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



```
(base) liyuxuan@gpu09:~/TACC_tutorial/DDP$ tcloud cat slurm_log/slurm-26364.out
Train Epoch: 1 [0/60000 (0%)]	Loss: 2.573273
Train Epoch: 1 [2560/60000 (4%)]	Loss: 0.695181
Train Epoch: 1 [5120/60000 (9%)]	Loss: 0.406518
Train Epoch: 1 [7680/60000 (13%)]	Loss: 0.294751
Train Epoch: 1 [10240/60000 (17%)]	Loss: 0.238092
Train Epoch: 1 [12800/60000 (21%)]	Loss: 0.231750
Train Epoch: 1 [15360/60000 (26%)]	Loss: 0.158637
Train Epoch: 1 [17920/60000 (30%)]	Loss: 0.128160
Train Epoch: 1 [20480/60000 (34%)]	Loss: 0.143385
Train Epoch: 1 [23040/60000 (38%)]	Loss: 0.190572
Train Epoch: 1 [25600/60000 (43%)]	Loss: 0.126529
Train Epoch: 1 [28160/60000 (47%)]	Loss: 0.163907
Train Epoch: 1 [30720/60000 (51%)]	Loss: 0.134790
```

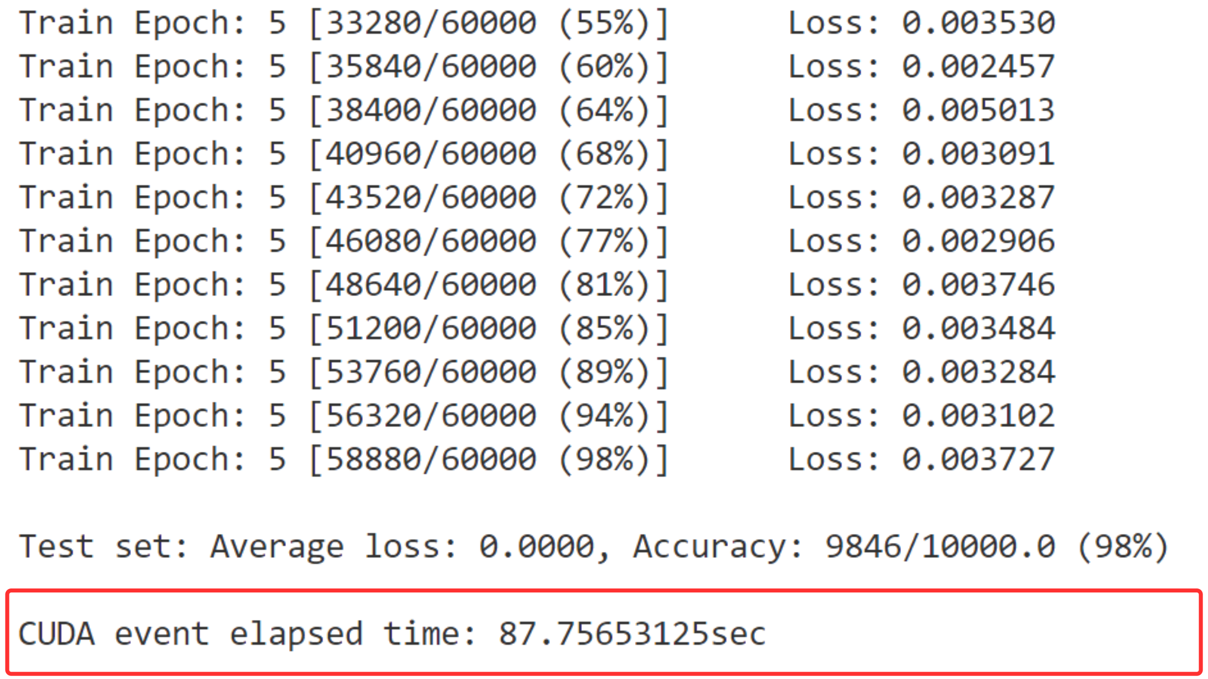
  - Run tcloud ls slurm_log if you forget your job id



```
(base) liyuxuan@gpu09:~/TACC_tutorial/DDP$ tcloud ls slurm_log
slurm-26345.out  slurm-26349.out  slurm-26354.out  slurm-26364.out
slurm-26346.out  slurm-26350.out  slurm-26361.out
slurm-26347.out  slurm-26351.out  slurm-26362.out
slurm-26348.out  slurm-26353.out  slurm-26363.out
```

SubmitDDP & FSDP codes for HW Q3

- Check the CUDA elapsed time to record the training duration



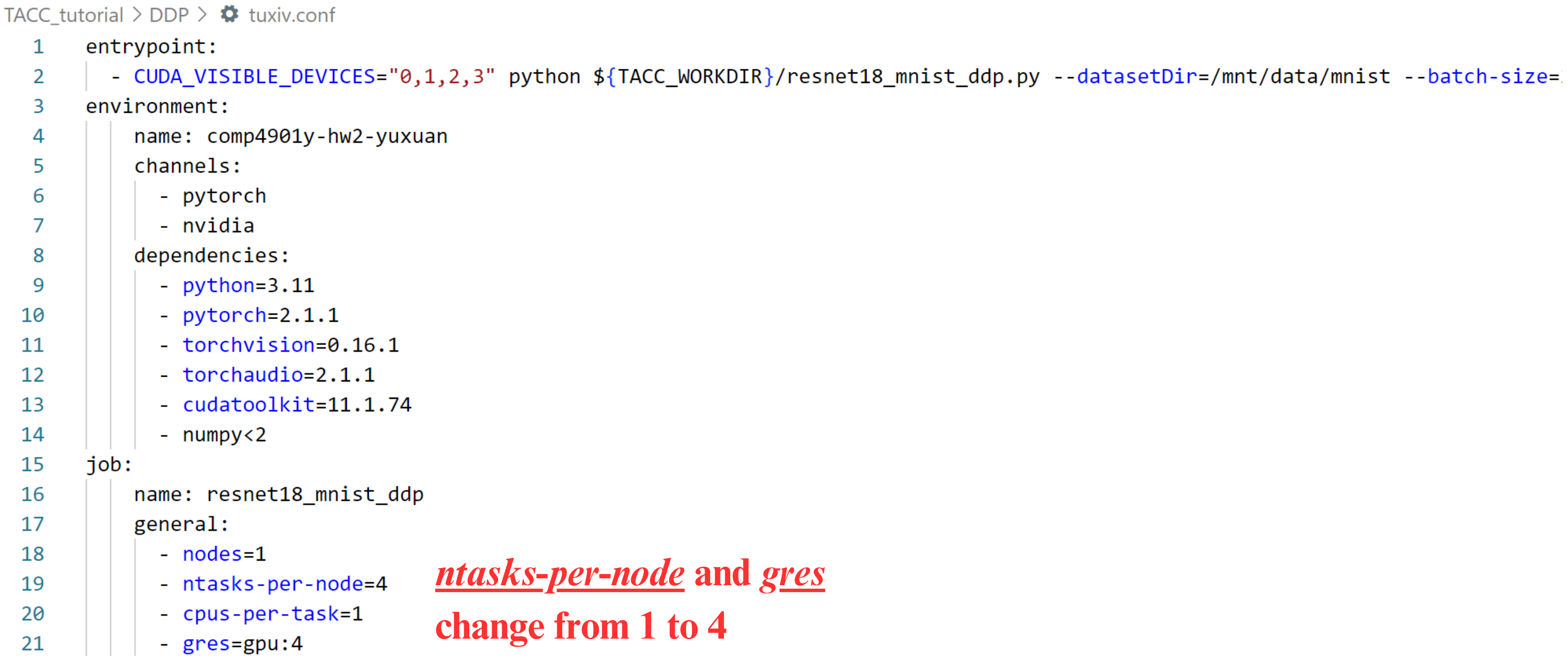
```
Train Epoch: 5 [33280/60000 (55%)]      Loss: 0.003530
Train Epoch: 5 [35840/60000 (60%)]      Loss: 0.002457
Train Epoch: 5 [38400/60000 (64%)]      Loss: 0.005013
Train Epoch: 5 [40960/60000 (68%)]      Loss: 0.003091
Train Epoch: 5 [43520/60000 (72%)]      Loss: 0.003287
Train Epoch: 5 [46080/60000 (77%)]      Loss: 0.002906
Train Epoch: 5 [48640/60000 (81%)]      Loss: 0.003746
Train Epoch: 5 [51200/60000 (85%)]      Loss: 0.003484
Train Epoch: 5 [53760/60000 (89%)]      Loss: 0.003284
Train Epoch: 5 [56320/60000 (94%)]      Loss: 0.003102
Train Epoch: 5 [58880/60000 (98%)]      Loss: 0.003727

Test set: Average loss: 0.0000, Accuracy: 9846/10000.0 (98%)

CUDA event elapsed time: 87.75653125sec
```

SubmitDDP & 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



TACC_tutorial > DDP > ⚙ tuxiv.conf

```
entrypoint:
  - CUDA_VISIBLE_DEVICES="0,1,2,3" python ${TACC_WORKDIR}/resnet18_mnist_ddp.py --datasetDir=/mnt/data/mnist --batch-size=
environment:
    name: comp4901y-hw2-yuxuan
    channels:
      - pytorch
      - nvidia
    dependencies:
      - python=3.11
      - pytorch=2.1.1
      - torchvision=0.16.1
      - torchaudio=2.1.1
      - cudatoolkit=11.1.74
      - numpy<2
job:
    name: resnet18_mnist_ddp
    general:
      - nodes=1
      - ntasks-per-node=4
      - cpus-per-task=1
      - gres=gpu:4
```

ntasks-per-node **and** ***gres***

change from 1 to 4

SubmitDDP & FSDP codes for HW Q3

- Record the training duration for different parallelisms
  - Reference duration for DDP
    - 87.7565, 51.8104, 39.4721, 31.4842
  - Reference duration for FSDP
    - 76.3156, 53.2009, 42.9850, 37.5470

Office Hour for Q&A: TBD
Room 3662, Academic Building

Contact: ylisn@connect.ust.hk