

SLURM - Simple Linux Utility for Resource Management

Introduction

Slurm is an open source, fault-tolerant, and highly scalable cluster management and job scheduling system for large and small Linux clusters.

It provides three key functions:

- allocating exclusive and/or non-exclusive access to resources (computer nodes) to users for some duration of time so they can perform work,
- providing a framework for starting, executing, and monitoring work (typically a parallel job such as MPI) on a set of allocated nodes, and
- arbitrating contention for resources by managing a queue of pending jobs.



Installation

Controller name: slurm-ctrl

Install slurm-wlm and tools

```
ssh slurm-ctrl
apt install slurm-wlm slurm-wlm-doc mailutils mariadb-client mariadb-server
libmariadb-dev python-dev python-mysqldb
```

Install Maria DB Server

```
apt-get install mariadb-server
systemctl start mysql
mysql -u root
create database slurm_acct_db;
create user 'slurm'@'localhost';
set password for 'slurm'@'localhost' = password('slurmdbpass');
grant usage on *.* to 'slurm'@'localhost';
grant all privileges on slurm_acct_db.* to 'slurm'@'localhost';
flush privileges;
exit
```

In the file /etc/mysql/mariadb.conf.d/50-server.cnf we should have the following setting:

```
vi /etc/mysql/mariadb.conf.d/50-server.cnf
```

```
bind-address = localhost
```

Node Authentication

First, let us configure the default options for the munge service:

```
vi /etc/default/munge
OPTIONS="--syslog --key-file /etc/munge/munge.key"
```

Central Controller

The main configuration file is `/etc/slurm-llnl/slurm.conf` this file has to be present in the controller and `*ALL*` of the compute nodes and it also has to be consistent between all of them.

```
vi /etc/slurm-llnl/slurm.conf
```

```
#####
# /etc/slurm-llnl/slurm.conf
#####
# slurm.conf file generated by configurator easy.html.
# Put this file on all nodes of your cluster.
# See the slurm.conf man page for more information.
#
ControlMachine=slurm-ctrl
#ControlAddr=10.7.20.97
#
#MailProg=/bin/mail
MpiDefault=none
#MpiParams=ports=#-#
ProctrackType=proctrack/pgid
ReturnToService=1
SlurmctldPidFile=/var/run/slurm-llnl/slurmctld.pid
##SlurmctldPidFile=/var/run/slurmctld.pid
#SlurmctldPort=6817
SlurmdPidFile=/var/run/slurm-llnl/slurmd.pid
##SlurmdPidFile=/var/run/slurmd.pid
#SlurmdPort=6818
SlurmdSpoolDir=/var/spool/slurmd
SlurmUser=slurm
#SlurmdUser=root
StateSaveLocation=/var/spool
SwitchType=switch/none
TaskPlugin=task/none
#
#
# TIMERS
#KillWait=30
#MinJobAge=300
```

```
#SlurmctldTimeout=120
#SlurmdTimeout=300
#
#
# SCHEDULING
FastSchedule=1
SchedulerType=sched/backfill
SelectType=select/linear
#SelectTypeParameters=
#
#
# LOGGING AND ACCOUNTING
AccountingStorageType=accounting_storage/none
ClusterName=cluster
#JobAcctGatherFrequency=30
JobAcctGatherType=jobacct_gather/none
#SlurmctldDebug=3
SlurmctldLogFile=/var/log/slurm-llnl/SlurmctldLogFile
#SlurmdDebug=3
SlurmdLogFile=/var/log/slurm-llnl/SlurmLogFile
#
#
# COMPUTE NODES
NodeName=linux1 NodeAddr=10.7.20.98 CPUs=1 State=UNKNOWN
```

Copy slurm.conf to compute nodes!

```
root@slurm-ctrl# scp /etc/slurm-llnl/slurm.conf csadmin@10.7.20.109:/tmp/.;
scp /etc/slurm-llnl/slurm.conf csadmin@10.7.20.110:/tmp/.
```

```
vi /lib/systemd/system/slurmctld.service
```

```
[Unit]
Description=Slurm controller daemon
After=network.target munge.service
ConditionPathExists=/etc/slurm-llnl/slurm.conf
Documentation=man:slurmctld(8)

[Service]
Type=forking
EnvironmentFile=-/etc/default/slurmctld
ExecStart=/usr/sbin/slurmctld $SLURMCTLD_OPTIONS
ExecStartPost=/bin/sleep 2
ExecReload=/bin/kill -HUP $MAINPID
PIDFile=/var/run/slurm-llnl/slurmctld.pid

[Install]
WantedBy=multi-user.target
```

```
vi /lib/systemd/system/slurmd.service
```

```
[Unit]
Description=Slurm node daemon
After=network.target munge.service
ConditionPathExists=/etc/slurm-llnl/slurm.conf
Documentation=man:slurmd(8)

[Service]
Type=forking
EnvironmentFile=-/etc/default/slurmd
ExecStart=/usr/sbin/slurmd $SLURMD_OPTIONS
ExecStartPost=/bin/sleep 2
ExecReload=/bin/kill -HUP $MAINPID
PIDFile=/var/run/slurm-llnl/slurmd.pid
KillMode=process
LimitNOFILE=51200
LimitMEMLOCK=infinity
LimitSTACK=infinity

[Install]
WantedBy=multi-user.target
```

```
root@slurm-ctrl# systemctl daemon-reload
root@slurm-ctrl# systemctl enable slurmdbd
root@slurm-ctrl# systemctl start slurmdbd
root@slurm-ctrl# systemctl enable slurmctld
root@slurm-ctrl# systemctl start slurmctld
```

Accounting Storage

After we have the slurm-llnl-slurmdbd package installed we configure it, by editing the /etc/slurm-llnl/slurmdbd.conf file:

```
vi /etc/slurm-llnl/slurmdbd.conf
```

```
#####
#
# /etc/slurm-llnl/slurmdbd.conf is an ASCII file which describes Slurm
# Database Daemon (SlurmDBD) configuration information.
# The contents of the file are case insensitive except for the names of
# nodes and files. Any text following a "#" in the configuration file is
# treated as a comment through the end of that line. The size of each
# line in the file is limited to 1024 characters. Changes to the
# configuration file take effect upon restart of SlurmDBD or daemon
# receipt of the SIGHUP signal unless otherwise noted.
#
# This file should be only on the computer where SlurmDBD executes and
# should only be readable by the user which executes SlurmDBD (e.g.
# "slurm"). This file should be protected from unauthorized access since
# it contains a database password.
```

```
#####  
AuthType=auth/munge  
AuthInfo=/var/run/munge/munge.socket.2  
StorageHost=localhost  
StoragePort=3306  
StorageUser=slurm  
StoragePass=slurmdbpass  
StorageType=accounting_storage/mysql  
StorageLoc=slurm_acct_db  
LogFile=/var/log/slurm-llnl/slurmdbd.log  
PidFile=/var/run/slurm-llnl/slurmdbd.pid  
SlurmUser=slurm
```

```
root@slurm-ctrl# systemctl start slurmdbd
```

Authentication

Copy /etc/munge.key to all compute nodes

```
scp /etc/munge/munge.key csadmin@10.7.20.98:/tmp/.
```

Allow password-less access to slurm-ctrl

```
csadmin@slurm-ctrl:~$ ssh-copy-id -i .ssh/id_rsa.pub 10.7.20.102:
```

Run a job from slurm-ctrl

```
ssh csadmin@slurm-ctrl  
srun -N 1 hostname  
linux1
```

Test munge

```
munge -n | unmunge | grep STATUS  
STATUS:          Success (0)  
munge -n | ssh slurm-ctrl unmunge | grep STATUS  
STATUS:          Success (0)
```

Test Slurm

```
sinfo  
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST  
debug*      up    infinite      1   idle linux1
```

If computer node is **down** or **drain**

```
sinfo -a
```

PARTITION	AVAIL	TIMELIMIT	NODES	STATE	NODELIST
debug*	up	infinite	2	down	gpu[02-03]

```
sinfo
```

PARTITION	AVAIL	TIMELIMIT	NODES	STATE	NODELIST
gpu*	up	infinite	1	drain	gpu02
gpu*	up	infinite	1	down	gpu03

```
scontrol update nodename=gpu02 state=idle
scontrol update nodename=gpu03 state=idle
scontrol update nodename=gpu02 state=resume
```

```
sinfo -a
```

PARTITION	AVAIL	TIMELIMIT	NODES	STATE	NODELIST
debug*	up	infinite	2	idle	gpu[02-03]

Compute Nodes

A compute node is a machine which will receive jobs to execute, sent from the Controller, it runs the slurmd service.



Installation slurm and munge

```
ssh -l csadmin <compute-nodes> 10.7.20.109 10.7.20.110
sudo apt install slurm-wlm libmunge-dev libmunge2 munge
```

```
sudo vi /lib/systemd/system/slurmd.service
```

```
[Unit]
Description=Slurm node daemon
After=network.target munge.service
ConditionPathExists=/etc/slurm-llnl/slurm.conf
Documentation=man:slurmd(8)
```

```
[Service]
Type=forking
EnvironmentFile=-/etc/default/slurmd
ExecStart=/usr/sbin/slurmd $SLURMD_OPTIONS
ExecStartPost=/bin/sleep 2
ExecReload=/bin/kill -HUP $MAINPID
PIDFile=/var/run/slurm-llnl/slurmd.pid
KillMode=process
LimitNOFILE=51200
LimitMEMLOCK=infinity
LimitSTACK=infinity
```

```
[Installl]  
WantedBy=multi-user.target
```

```
sudo systemctl enable slurmd  
sudo systemctl enable munge  
sudo systemctl start slurmd  
sudo systemctl start munge
```

Generate ssh keys

```
ssh-keygen
```

Copy ssh-keys to slurm-ctrl

```
ssh-copy-id -i ~/.ssh/id_rsa.pub csadmin@slurm-ctrl.inf.unibz.it:
```

Become root to do important things:

```
sudo -i  
vi /etc/hosts
```

Add those lines below to the /etc/hosts file

```
10.7.20.97      slurm-ctrl.inf.unibz.it slurm-ctrl  
10.7.20.98      linux1.inf.unibz.it     linux1
```

First copy the munge keys from the slurm-ctrl to all compute nodes, now fix location, owner and permission.

```
mv /tmp/munge.key /etc/munge/.  
chown munge:munge /etc/munge/munge.key  
chmod 400 /etc/munge/munge.key
```

Place /etc/slurm-llnl/slurm.conf in right place,

```
mv /tmp/slurm.conf /etc/slurm-llnl/  
chown root: /etc/slurm-llnl/slurm.conf
```

Links

[Slurm Workload Manager Overview](#)

[Steps to create a small slurm cluster with GPU enabled nodes](#)

[Slurm in Ubuntu Clusters Part1](#)

[Slurm batch queueing system](#)

[SLURM Workload Manager](#)

Slurm Quick Start Tutorial

Linux Clusters Institute: Scheduling and Resource Management 2017

Modules

Python

Python 3.7.7

```
cd /opt/packages
mkdir /opt/packages/python/3.7.7
wget https://www.python.org/ftp/python/3.7.7/Python-3.7.7.tar.xz
tar xfJ Python-3.7.7.tar.xz
cd Python-3.7.7/
./configure --prefix=/opt/packages/python/3.7.7/ --enable-optimizations
make
make install
```

Python 2.7.18

```
cd /opt/packages
mkdir /opt/packages/python/2.7.18
wget https://www.python.org/ftp/python/2.7.18/Python-2.7.18.tar.xz
cd Python-2.7.18
./configure --prefix=/opt/packages/python/2.7.18/ --enable-optimizations
make
make install
```

Create modules file

```
cd /opt/modules/modulefiles/
vi python-2.7.18
```

```
#!/Module1.0
proc ModulesHelp { } {
  global dotversion

  puts stderr "\tPython 2.7.18"
}

module-whatis "Python 2.7.18"
prepend-path PATH /opt/packages/python/2.7.18/bin
```


GCC

This takes a long time!

Commands to run to compile gcc-6.1.0

```
wget https://ftp.gnu.org/gnu/gcc/gcc-6.1.0/gcc-6.1.0.tar.bz2
tar xjf gcc-6.1.0.tar.bz2
cd gcc-6.1.0
./contrib/download_prerequisites
./configure --prefix=/opt/package/gcc/6.1.0 --disable-multilib
make
```

After some time an error occurs, and the make process stops!

```
...
In file included from ../.././libgcc/unwind-dw2.c:401:0:
./md-unwind-support.h: In function 'x86_64_fallback_frame_state':
./md-unwind-support.h:65:47: error: dereferencing pointer to incomplete type
'struct ucontext'
        sc = (struct sigcontext *) (void *) &uc_>uc_mcontext;
                                                ^~
../.././libgcc/shared-object.mk:14: recipe for target 'unwind-dw2.o' failed
```

To fix do: [solution](#)

```
vi /opt/packages/gcc-6.1.0/x86_64-pc-linux-gnu/libgcc/md-unwind-support.h
```

and replace/comment out line 61 with this:

```
struct ucontext_t *uc_ = context->cfa;
```

old line: `/* struct ucontext *uc_ = context->cfa; */`

```
make
```

Next error:

```
../../././././libsanitizer/sanitizer_common/sanitizer_stoptheworld_linux_libcdep.cc:270:22: error: aggregate 'sigaltstack handler_stack' has incomplete type and cannot be defined
    struct sigaltstack handler_stack;
```

To fix see: [solution](#) or https://gcc.gnu.org/bugzilla/show_bug.cgi?id=81066

Amend the files according to solution above!

Next error:

```
...
checking for unzip... unzip
configure: error: cannot find neither zip nor jar, cannot continue
Makefile:23048: recipe for target 'configure-target-libjava' failed
...
...
```

```
apt install unzip zip
```

and run make again!

```
make
```

Next error:

```
...
In file included from ../.././libjava/prims.cc:26:0:
../.././libjava/prims.cc: In function 'void _Jv_catch_fpe(int, siginfo_t*,
void*)':
./include/java-signal.h:32:26: error: invalid use of incomplete type 'struct
_Jv_catch_fpe(int, siginfo_t*, void*)::ucontext'
    gregset_t &_gregs = _uc->uc_mcontext.gregs;    \
...

```

Edit the file: /opt/packages/gcc-6.1.0/x86_64-pc-linux-gnu/libjava/include/java-signal.h

```
vi /opt/packages/gcc-6.1.0/x86_64-pc-linux-gnu/libjava/include/java-signal.h
```

Not enough more errors!

```
// kh
    ucontext_t *_uc = (ucontext_t *);                                \
    //struct ucontext *_uc = (struct ucontext *)_p;
\
    // kh
```

Next error:

```
...
In file included from ../.././libjava/prims.cc:26:0:
./include/java-signal.h:32:3: warning: multi-line comment [-Wcomment]
    //struct ucontext *_uc = (struct ucontext *)_p;    \
    ^
../.././libjava/prims.cc: In function 'void _Jv_catch_fpe(int, siginfo_t*,
void*)':
./include/java-signal.h:31:15: warning: unused variable '_uc' [-Wunused-
variable]
    ucontext_t *_uc = (ucontext_t *)_p;    \
    ^
../.././libjava/prims.cc:192:3: note: in expansion of macro
```

```

'HANDLE_DIVIDE_OVERFLOW'
HANDLE_DIVIDE_OVERFLOW;
^~~~~~
../../../../libjava/prims.cc:203:1: error: expected 'while' before 'jboolean'
jboolean
^~~~~~
../../../../libjava/prims.cc:203:1: error: expected '(' before 'jboolean'
../../../../libjava/prims.cc:204:1: error: expected primary-expression before
'_Jv_equalUtf8Consts'
_Jv_equalUtf8Consts (const Utf8Const* a, const Utf8Const *b)
^~~~~~
../../../../libjava/prims.cc:204:1: error: expected ')' before
'_Jv_equalUtf8Consts'
../../../../libjava/prims.cc:204:1: error: expected ';' before
'_Jv_equalUtf8Consts'
../../../../libjava/prims.cc:204:22: error: expected primary-expression before
'const'
_Jv_equalUtf8Consts (const Utf8Const* a, const Utf8Const *b)
...

```

Examples

Example mnist

An simple example to use nvidia GPU!

The example consists of the following files:

- README.md
- requirements.txt
- main.job
- main.py

Create a folder mnist and place the 4 files in there.

```
mkdir mnist
```

```
cat README.md
```

```

# Basic MNIST Example

```bash
pip install -r requirements.txt
python main.py
CUDA_VISIBLE_DEVICES=2 python main.py # to specify GPU id to ex. 2
```

```

```
cat requirements.txt
```

```
torch
torchvision
```

```
cat main.job
```

```
#!/bin/bash

#SBATCH --job-name=mnist
#SBATCH --output=mnist.out
#SBATCH --error=mnist.err

#SBATCH --partition gpu
#SBATCH --gres=gpu
#SBATCH --mem-per-cpu=4gb
#SBATCH --nodes 2
#SBATCH --time=00:08:00

#SBATCH --ntasks=10

#SBATCH --mail-type=ALL
#SBATCH --mail-user=<your-email@address.com>

ml load miniconda3
python3 main.py
```

main.py

```
from __future__ import print_function
import argparse
import torch
import torch.nn as nn
import torch.nn.functional as F
import torch.optim as optim
from torchvision import datasets, transforms
from torch.optim.lr_scheduler import StepLR

class Net(nn.Module):
    def __init__(self):
        super(Net, self).__init__()
        self.conv1 = nn.Conv2d(1, 32, 3, 1)
        self.conv2 = nn.Conv2d(32, 64, 3, 1)
        self.dropout1 = nn.Dropout2d(0.25)
        self.dropout2 = nn.Dropout2d(0.5)
        self.fc1 = nn.Linear(9216, 128)
        self.fc2 = nn.Linear(128, 10)

    def forward(self, x):
        x = self.conv1(x)
        x = F.relu(x)
        x = self.conv2(x)
        x = F.max_pool2d(x, 2)
        x = self.dropout1(x)
        x = torch.flatten(x, 1)
        x = self.fc1(x)
        x = F.relu(x)
        x = self.dropout2(x)
        x = self.fc2(x)
        output = F.log_softmax(x, dim=1)
        return output

def train(args, model, device, train_loader, optimizer, epoch):
    model.train()
    for batch_idx, (data, target) in enumerate(train_loader):
        data, target = data.to(device), target.to(device)
        optimizer.zero_grad()
        output = model(data)
        loss = F.nll_loss(output, target)
        loss.backward()
        optimizer.step()
        if batch_idx % args.log_interval == 0:
            print('Train Epoch: {} [{}/{}] ({:.0f}%) \t Loss: {:.6f}'.format(
                epoch, batch_idx * len(data), len(train_loader.dataset),
                100. * batch_idx / len(train_loader), loss.item()))

def test(args, model, device, test_loader):
    model.eval()
    test_loss = 0
    correct = 0
    with torch.no_grad():
        for data, target in test_loader:
            data, target = data.to(device), target.to(device)
            output = model(data)
            test_loss += F.nll_loss(output, target, reduction='sum').item()
            # sum up batch loss
            pred = output.argmax(dim=1, keepdim=True)
            # get the index of the max log-probability
            correct += pred.eq(target.view_as(pred)).sum().item()

    test_loss /= len(test_loader.dataset)
    print('\nTest set: Average loss: {:.4f}, Accuracy: {}/{} ({:.0f}%) \n'.format(
        test_loss, correct, len(test_loader.dataset), 100. * correct / len(test_loader.dataset)))

def main():
    # Training settings
    parser = argparse.ArgumentParser(description='PyTorch MNIST Example')
    parser.add_argument('--batch-size', type=int, default=64, metavar='N', help='input batch size')
```

```

for training (default: 64)) parser.add_argument('--test-batch-size', type=int, default=1000,
metavar='N', help='input batch size for testing (default: 1000)') parser.add_argument('--
epochs', type=int, default=14, metavar='N', help='number of epochs to train (default: 14)')
parser.add_argument('--lr', type=float, default=1.0, metavar='LR', help='learning rate (default:
1.0)') parser.add_argument('--gamma', type=float, default=0.7, metavar='M', help='Learning
rate step gamma (default: 0.7)') parser.add_argument('--no-cuda', action='store_true',
default=False, help='disables CUDA training') parser.add_argument('--seed', type=int,
default=1, metavar='S', help='random seed (default: 1)') parser.add_argument('--log-interval',
type=int, default=10, metavar='N', help='how many batches to wait before logging training
status') parser.add_argument('--save-model', action='store_true', default=False, help='For
Saving the current Model') args = parser.parse_args() use_cuda = not args.no_cuda and
torch.cuda.is_available() torch.manual_seed(args.seed) device = torch.device("cuda" if
use_cuda else "cpu") kwargs = {'num_workers': 1, 'pin_memory': True} if use_cuda else {}
train_loader = torch.utils.data.DataLoader( datasets.MNIST('./data', train=True,
download=True, transform=transforms.Compose([ transforms.ToTensor(),
transforms.Normalize((0.1307,), (0.3081,)) ])), batch_size=args.batch_size, shuffle=True,
**kwargs) test_loader = torch.utils.data.DataLoader( datasets.MNIST('./data', train=False,
transform=transforms.Compose([ transforms.ToTensor(), transforms.Normalize((0.1307,),
(0.3081,)) ])), batch_size=args.test_batch_size, shuffle=True, **kwargs) model =
Net().to(device) optimizer = optim.Adadelta(model.parameters(), lr=args.lr) scheduler =
StepLR(optimizer, step_size=1, gamma=args.gamma) for epoch in range(1, args.epochs + 1):
train(args, model, device, train_loader, optimizer, epoch) test(args, model, device, test_loader)
scheduler.step() if args.save_model: torch.save(model.state_dict(), "mnist_cnn.pt") if __name__
== '__main__': main()

```

```

1.
2.
3. from __future__ import print_function
4. import argparse
5. import torch
6. import torch.nn as nn
7. import torch.nn.functional as F
8. import torch.optim as optim
9. from torchvision import datasets, transforms
10. from torch.optim.lr_scheduler import StepLR
11.
12.
13. class Net(nn.Module):
14.     def __init__(self):
15.         super(Net, self).__init__()
16.         self.conv1 = nn.Conv2d(1, 32, 3, 1)
17.         self.conv2 = nn.Conv2d(32, 64, 3, 1)
18.         self.dropout1 = nn.Dropout2d(0.25)
19.         self.dropout2 = nn.Dropout2d(0.5)
20.         self.fc1 = nn.Linear(9216, 128)
21.         self.fc2 = nn.Linear(128, 10)
22.
23.     def forward(self, x):
24.         x = self.conv1(x)
25.         x = F.relu(x)
26.         x = self.conv2(x)
27.         x = F.max_pool2d(x, 2)
28.         x = self.dropout1(x)
29.         x = torch.flatten(x, 1)

```

```
30.         x = self.fc1(x)
31.         x = F.relu(x)
32.         x = self.dropout2(x)
33.         x = self.fc2(x)
34.         output = F.log_softmax(x, dim=1)
35.         return output
36.
37.
38. def train(args, model, device, train_loader, optimizer, epoch):
39.     model.train()
40.     for batch_idx, (data, target) in enumerate(train_loader):
41.         data, target = data.to(device), target.to(device)
42.         optimizer.zero_grad()
43.         output = model(data)
44.         loss = F.nll_loss(output, target)
45.         loss.backward()
46.         optimizer.step()
47.         if batch_idx % args.log_interval == 0:
48.             print('Train Epoch: {} [{}/{} ({:.0f}%)]\tLoss:
{:.6f}'.format(
49.                 epoch, batch_idx * len(data), len(train_loader.dataset),
50.                 100. * batch_idx / len(train_loader), loss.item()))
51.
52.
53. def test(args, model, device, test_loader):
54.     model.eval()
55.     test_loss = 0
56.     correct = 0
57.     with torch.no_grad():
58.         for data, target in test_loader:
59.             data, target = data.to(device), target.to(device)
60.             output = model(data)
61.             test_loss += F.nll_loss(output, target,
reduction='sum').item() # sum up batch loss
62.             pred = output.argmax(dim=1, keepdim=True) # get the index
of the max log-probability
63.             correct += pred.eq(target.view_as(pred)).sum().item()
64.
65.     test_loss /= len(test_loader.dataset)
66.
67.     print('\nTest set: Average loss: {:.4f}, Accuracy: {}/{}
{:.0f}%)\n'.format(
68.         test_loss, correct, len(test_loader.dataset),
69.         100. * correct / len(test_loader.dataset)))
70.
71.
72. def main():
73.     # Training settings
74.     parser = argparse.ArgumentParser(description='PyTorch MNIST
Example')
75.     parser.add_argument('--batch-size', type=int, default=64,
metavar='N',
76.                           help='input batch size for training (default:
64)')
77.     parser.add_argument('--test-batch-size', type=int, default=1000,
metavar='N',
```

```
78.             help='input batch size for testing (default:
1000)')
79.     parser.add_argument('--epochs', type=int, default=14, metavar='N',
80.             help='number of epochs to train (default: 14)')
81.     parser.add_argument('--lr', type=float, default=1.0, metavar='LR',
82.             help='learning rate (default: 1.0)')
83.     parser.add_argument('--gamma', type=float, default=0.7, metavar='M',
84.             help='Learning rate step gamma (default: 0.7)')
85.     parser.add_argument('--no-cuda', action='store_true', default=False,
86.             help='disables CUDA training')
87.     parser.add_argument('--seed', type=int, default=1, metavar='S',
88.             help='random seed (default: 1)')
89.     parser.add_argument('--log-interval', type=int, default=10,
metavar='N',
90.             help='how many batches to wait before logging
training status')
91.
92.     parser.add_argument('--save-model', action='store_true',
default=False,
93.             help='For Saving the current Model')
94.     args = parser.parse_args()
95.     use_cuda = not args.no_cuda and torch.cuda.is_available()
96.
97.     torch.manual_seed(args.seed)
98.
99.     device = torch.device("cuda" if use_cuda else "cpu")
100.
101.     kwargs = {'num_workers': 1, 'pin_memory': True} if use_cuda else {}
102.     train_loader = torch.utils.data.DataLoader(
103.         datasets.MNIST('../data', train=True, download=True,
104.             transform=transforms.Compose([
105.                 transforms.ToTensor(),
106.                 transforms.Normalize((0.1307,), (0.3081,))
107.             ])),
108.         batch_size=args.batch_size, shuffle=True, **kwargs)
109.     test_loader = torch.utils.data.DataLoader(
110.         datasets.MNIST('../data', train=False,
transform=transforms.Compose([
111.             transforms.ToTensor(),
112.             transforms.Normalize((0.1307,), (0.3081,))
113.         ])),
114.         batch_size=args.test_batch_size, shuffle=True, **kwargs)
115.
116.     model = Net().to(device)
117.     optimizer = optim.Adadelta(model.parameters(), lr=args.lr)
118.
119.     scheduler = StepLR(optimizer, step_size=1, gamma=args.gamma)
120.     for epoch in range(1, args.epochs + 1):
121.         train(args, model, device, train_loader, optimizer, epoch)
122.         test(args, model, device, test_loader)
123.         scheduler.step()
124.
125.     if args.save_model:
126.         torch.save(model.state_dict(), "mnist_cnn.pt")
127.
128.
```

```
129. if __name__ == '__main__':  
130.     main()  
131.  
132.
```

Links

<https://www.admin-magazine.com/HPC/Articles/Warewulf-Cluster-Manager-Development-and-Run-Time/Warewulf-3-Code/MPICH2>

https://proteusmaster.urcf.drexel.edu/urcfwiki/index.php/Environment_Modules_Quick_Start_Guide

[https://en.wikipedia.org/wiki/Environment_Modules_\(software\)](https://en.wikipedia.org/wiki/Environment_Modules_(software))

<http://www.walkingrandomly.com/?p=5680>

<https://modules.readthedocs.io/en/latest/index.html>

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