

Remote computing

Outline

- command-line (CLI) basics
- ssh
- tmux
- copying files between computers
- examples
 - MATLAB, X11 forwarding
 - outputting to a file
 - Jupyter notebooks
 - neural net, GPU



CLI basics

Navigation

- change directory:

```
cd
```

- list directory contents:

```
ls
```

- make directory:

```
mkdir
```

File operations

- copy files:

```
cp
```

- move files:

```
mv
```

- delete files:

```
rm
```

Misc

- redirect stdout to a file:

```
example-command > out.txt
```

- wildcards:

```
rm *.txt
```

- run in background:

```
some-command &
```

- tab completion: press tab to autocomplete commands, file names, etc.

Connecting to the remote computer Using SSH (secure shell protocol)

usage: ``ssh user@hostname``

example:

```
ssh trevor@bz-ece-whitgpu1
```

Note: when connected via the MSU VPN, add ``.msu.montana.edu`` to the hostname:

```
ssh bmw@bz-ece-whitlab1.msu.montana.edu
```

Ensuring jobs don't accidentally die



- By default, exiting the ssh session kills your jobs
- Sometimes ssh likes to exit on its own 😞



Use *tmux* so we can detach our processes from the controlling terminal

- Can have multiple panes (terminal multiplexing)
- Can have multiple windows
- Allows us to run multiple jobs easily

```
(line 31)
minfun = @(hyperparams)cvobjfun(@adaboost, hyperparams, ...

Error in BayesianOptimization/callObjNormally (line 2641)
    [Objective, ConstraintViolations, UserData] = this.ObjectiveFcn(conditionalizeX(this, X));

Error in BayesianOptimization/callObjFcn (line 467)
    = callObjNormally(this, X);

Error in BayesianOptimization/runSerial (line 2048)
    ObjectiveFcnObjectiveEvaluationTime, ObjectiveNargout] = callObjFcn(this, this.XNext);

Error in BayesianOptimization/run (line 1996)
    this = runSerial(this);

Error in BayesianOptimization (line 457)
    this = run(this);

Error in bayesopt (line 323)
    Results = BayesianOptimization(Options);

Error in tuneHyperparamsAdaBoost (line 36)
    results = bayesopt(minfun, optimizeVars, ...

IdleTimeout has been reached.
Parallel pool using the 'local' profile is shutting down.
>> tuneHyperparamsAdaBoost
Starting parallel pool (parpool) using the 'local' profile ...
Connected to the parallel pool (number of workers: 8).

(base) [trevor@bmw-lab-fedora ~]$ neofetch

      /:-~~~~~\
      :-----:
      :/shhOHbmp\
      :/-----\
      :omMMMMNNMMMD
      :sMMMMNNMMMP
      :MMMMp-----\
      :MMMd-----:
      :MMMd-----:
      :MMMd-----:
      :oMMMMMMMMMMNho
      :+shhhMMmmhhy++
      :MMMd-----:
      :MMMd-----:
      :MMMd-----:
      :dMMdhhdMMMo
      :sdNMMMMNds
      :://-----:
      ://-----:

      OS: Fedora 33 (Workstation Edition) x86_64
      Kernel: 5.12.5-200.fc33.x86_64
      Uptime: 5 days, 11 hours, 53 mins
      Packages: 3316 (rpm), 8 (snap)
      Shell: bash 5.0.17
      Resolution: 1920x1080
      DE: Cinnamon 4.8.6
      CPU: Intel i9-9900K (16) @ 5.000GHz
      GPU: NVIDIA GeForce RTX 2070
      Memory: 22822MiB / 32016MiB

      Download
      ▼ 0 Byte/s (0 bits)
      ▼ Top: (1.28 Gbps)
      ▼ Total: 312 GiB
      ▲ 0 Byte/s (0 bits)
      ▲ Top: (1.28 Gbps)
      ▲ Total: 312 GiB
      Upload
```

tmux basics

- **create a new session**

```
tmux
```

- **attach to last session**

```
tmux attach
```

- **detach from a session**

```
ctrl+b d
```

- **create a new window**

```
ctrl+b c
```

- **change window**

```
ctrl+b <window-number>
```

- **split pane horizontally**

```
ctrl+b "
```

- **split pane vertically**

```
ctrl+b %
```

- **switch between panes**

```
ctrl+b <arrow-key>
```

GUIDES / CHEATSHEETS

- <https://www.ocf.berkeley.edu/~ckuehl/tmux/>
- <https://tmuxcheatsheet.com/>

Copying files using SCP (secure copy)




From local to remote:

```
scp file user@hostname:<location>  
  
scp test.py trevor@bz-ece-whitgpu1:~/project/
```

From remote to local:

```
scp user@hostname:<file-location> <local-file-location>  
  
scp trevor@bz-ece-whitgpu1:~/project/test.py some-dir/test2.py
```

NEED TO SYNC LOTS OF FILES?

- Globus, OneDrive, Box, etc. 
- use git for code (our lab has a GitHub Organization)  

Examples

Showing plot windows with X11 forwarding

What if we need plots?

```
x = 0:0.001:2*pi;  
y = sum(rand(4,1) .* sin(randi(5, 4, 1) * pi .* x + rand(4,1)));  
plot(x,y)
```

- use X11 forwarding if you only need to display a few graphics
- if you need lots of graphics, use VNC, RDP, etc.

X11 FORWARDING

```
ssh -Y user@hostname
```

- On Windows, use MobaXterm

Note: X11 forwarding might be obsolete in the future if Wayland becomes the de-facto display server

Multiple jobs, redirecting output to a file

REDIRECT OUTPUT

```
function silly(n)
disp("n = " + num2str(n))
pause(1)
disp("n^2 = " + num2str(n^2))
end
```

- run from cli and redirect output to a file

```
matlab -batch "silly 2" > 2.txt
```

- if you want to see the output while the program is running

```
matlab -batch "silly 2" | tee 2.txt
```

RUNNING MULTIPLE JOBS

1. run in the background using a trailing &
2. use multiple tmux windows/panes

Jupyter notebooks

- use port forwarding, a.k.a tunneling

```
ssh -L remote-port:host:host-port user@hostname
```

```
ssh -L 8888:localhost:8888 trevor@bmw-lab-fedora
```

- Jupyter notebook's default port is 8888
- launch notebook as so:

```
jupyter notebook --no-browser
```

Neural net with GPU

- take it away, Brad!