Introduction to Unix Computing in the Applied Mathematics Department

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Outline

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2. Basic Unix Commands
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3. Intermediate Unix Commands
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4. Advacned Unix Commands
   a. program redirection
   b. .bashrc
5. (Extras)

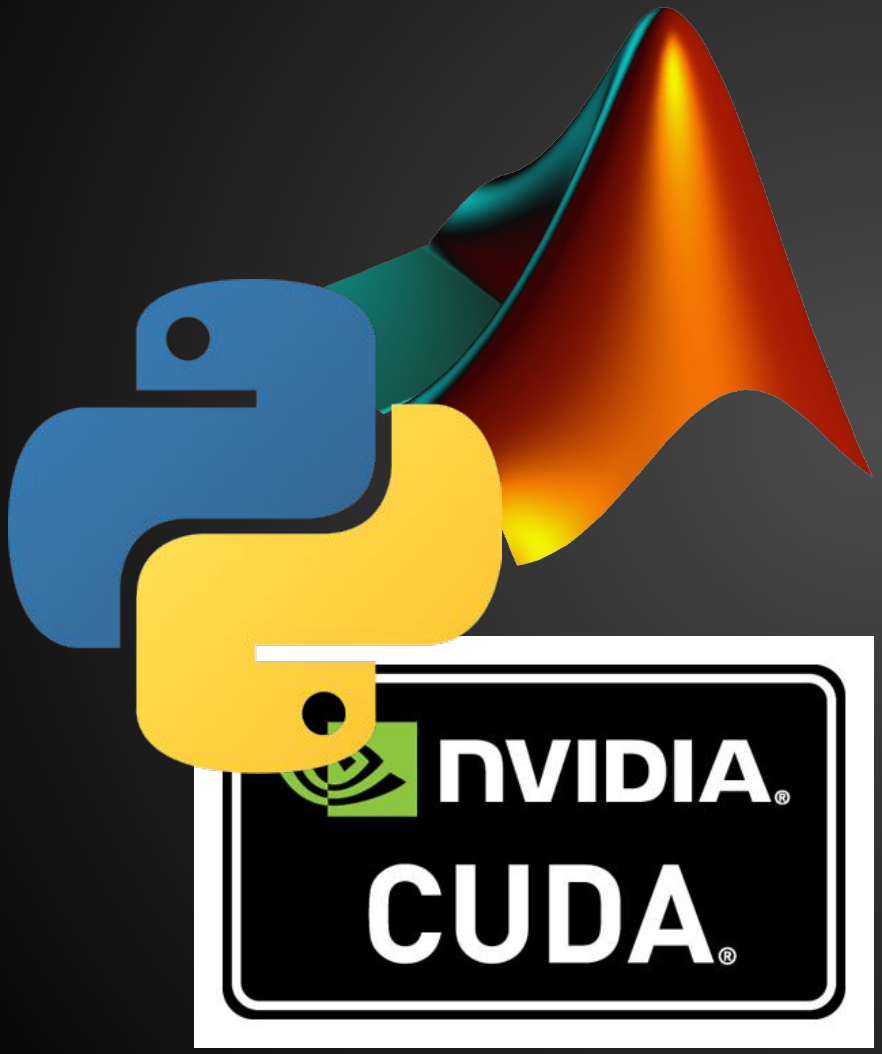
Our Equipment

- Linux Ubuntu 12.07 (non-milk coffees)
  - espresso.amath
    - x2 6-core Intel Xeon @ 3.07 GHz
    - L2 Cache (per core): 256 KB
    - L3 Cache (per proc): 12 MB
    - 24 GB RAM
    - NVIDIA Quatro 4000
      - 2 GB Device Global Memory
      - Double precision support
      - CUDA Compatible
  - americano.amath (coming soon!)

Our Equipment

- Apple OSX Lion (milk coffees)
  - latte.amath
  - mocha.amath
  - galao.amath
    - x2 6-core Intel Xeon @ 2.66 GHz
    - L2 Cache (per core): 256 KB
    - L3 Cache (per proc): 12 MB
    - 24 GB RAM
    - ATI Radeon HD 5870
      - 1GB Device Global Memory
      - Double precision support
      - Not CUDA Compatible
      - OpenCL Compatible

Installed Software



- **Mathematical**: Matlab, Maple, Python, Numpy, Scipy, matplotlib
- **Computational**: C/C++, FORTRAN, Python, CUDA (espresso only)
- **Logistic**: LaTeX, git, mercurial

Remotely Connecting

- via SSH (Secure Shell)
- OSX / Linux
  - Open Terminal
  - Type the following and hit 'Enter'

```
$ ssh myuwnetid@espresso.amath.washington.edu
```

  - Enter your UW NetID password and hit 'Enter'. (Note: password won't appear in terminal.)
- Windows
  - Download Google Chrome and Install “Secure Shell”

Demo...

(SSH'ing into espresso.amath)

A Quick Word About Dropbox

Use Dropbox to synchronize your files.

- OSX Instructions: (do the following once)
  - Physically log in to latte / mocha / galao
  - Setup using on-screen instructions
  - Lock screen (don't log out) by selecting the user list and scrolling down to "Lock Screen"
  - you can now ssh in and DB will run
- Linux Instructions
  - ssh into espresso / americano
  - run

```
$ dropbox start
```

(also: `$ dropbox autostart y`)

Basic Unix Commands

Unix-based computers are very common in math and science research. Get to know the Unix environment!

Resources:

- Using the Terminal
- Command Line
- Adv. Command Line

- `$ ls`
  - list directory contents
- `$ pwd`
  - print working/current directory
- `$ cd DIR`
  - change directory to DIR
  - "~" is home, "`..`" is parent
- `$ rm FILE`
  - remove / delete file. Cannot undo so be careful!
- `$ more FILE` or `$ less FILE`
  - view the contents of a file
- `$ top [-user username]`
  - view top CPU and memory using processes. Optionally, only those initiated / owned by `username`

Demo...

(basic terminal commands)

Intermediate Unix Commands

- `$ history`
  - shows past commands
- `$ man COMMAND`
  - manual page ("manpage") for COMMAND
  - use arrow keys or 'j' / 'k' to scroll
- `$ diff FILE1 FILE2`
  - compare two text files

File Management

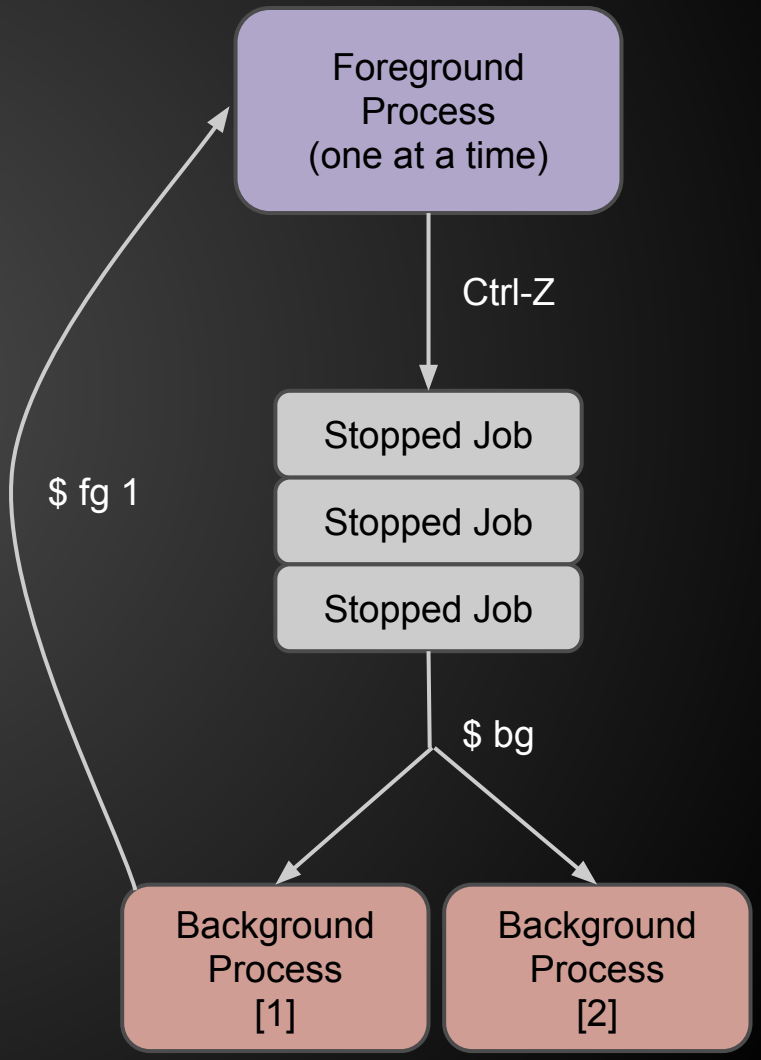
- `$ cp FILE DEST`
  - copy FILE to DEST
- `$ mv FILE DEST`
  - move FILE to DEST
- `$ du -sh DIR`
  - disk usage (hard drive space taken up) by DIR

Process Management

- `$ ps [-u USERNAME]`
  - list the processes started in this terminal session
  - (each process has a PID)
  - "`-u`" flag shows all processes owned by USERNAME
- `$ kill [-9] PID`
  - try to kill process PID
  - use the '`-9`' flag to force
- `$ nice -n7 COMMAND`
  - run COMMAND in a "nice" way. BE COURTEOUS TO YOUR FELLOW USERS!
- `$ renice +7 PID`
  - increase the "niceness" of process PID by 7 points

More Process Management

- Control-c
  - kill the currently running "foreground" process
- Control-z
  - stop (but don't kill) currently running foreground process
- `$ COMMAND &`
  - (include ampersand at end) runs COMMAND in the background allowing you to enter more commands
- `$ bg`
  - runs all stopped jobs in the background
- `$ jobs`
  - lists all background jobs
- `$ fg JOBNUMBER`
  - brings JOBNUMBER to the foreground



Demo...

(intermediate terminal commands)

Text Editors

Terminal-based text editors have a steep learning curve but greatly improve productivity.

- nano
  - easiest to use
  - tutorial: start nano and hit 'Control-g'
- vi / vim
  - tutorial: `$ vimtutor`
- emacs
  - tutorial: start emacs and hit 'Control-h' and then hit 't'.

Demo...

(opening text editor tutorials, editing files)

Intermediate Networking Commands

- Copy files from your computer to server

```
$ scp FILE myuwnetid@server:DIR/FILENAME
```

- `nohup`: execute COMMAND using `nohup` so it doesn't die when you disconnect. (output redirected to file)

```
$ nohup ping www.google.com &
```

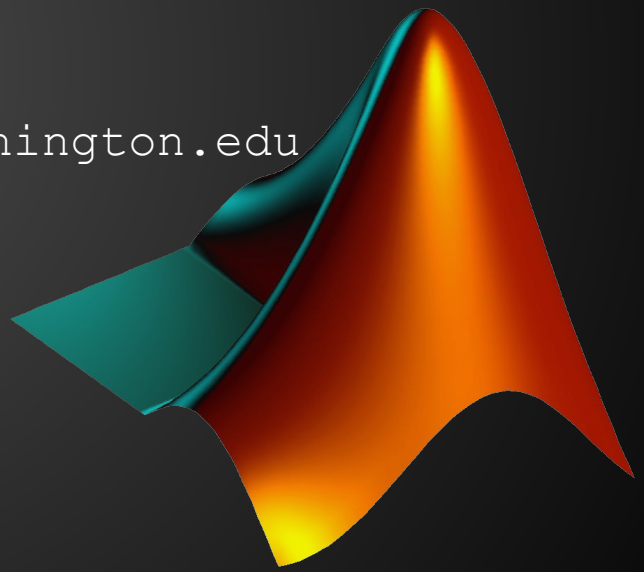
- `screen`: advanced tool for working with multiple terminals via ssh where, like in nohup, processes never die when you disconnect (they just fade away)

Matlab

- Cannot run Matlab interactively
  - requires X-windows forwarding. (High bandwidth.)

```
$ ssh -X user@server
```

```
$ ssh -X myuwnetid@latte.amath.washington.edu
$ matlab -nojvm
(Matlab startup)
>> plot([1,2,3],[-1,1,0],'g')
(plot is displayed)
>>
```



It's best to just run scripts that save plots to file and `scp` them back to your personal computer.

Demo...

(using Matlab via X-windows and `-nojvm`)

Advanced Unix Commands

Controlling Program Flow

- `$ COMMAND > FILE`
  - redirects output of COMMAND to FILE (overwrites if FILE exists)
- `$ COMMAND >> FILE`
  - appends output of COMMAND to end of FILE
- `$ COMMAND < FILE`
  - uses the contents of FILE as input to COMMAND
  - `$ sort < words.txt`
- `$ CMD1 | CMD2`
  - "pipes" the output of CMD1 to CMD2 as input
  - `$ ls | sort`
- You can string commands
  `$ ls | sort > sorted.txt`

Your .bashrc File

There is a special "hidden" file in your home directory called ".bashrc". Add terminal commands to the end and they will be executed every time you log in.

e.g. add

```
dropbox start
```

to start Dropbox upon logging in.

Other Tricks

```
alias ll='ls -l'
alias la='ls -a'

export PATH=~/bin:${PATH}
```

(add ~/bin to your "PATH" variable)

Demo...

(output redirection and a tour of .bashrc)

Questions?

Thank you!

Additional Tricks: Python and PDB

PDB (Python DeBugger) is a tool for stepping through your Python code line-by-line when debugging your code.

```
# script.py
import pdb
...
pdb.set_trace()
...
```

From command line:

```
$ python script.py
```

Navigation

`l`: (l)ook
`n`: (n)ext line
`s`: (s)tep into function
`c`: (c)ontinue to next breakpoint, error, or end of script

Additionally, you can execute Python commands from within the debugger. E.g.

```
(pdb) print x.norm()
```

Additional Tricks: screen

screen is a Unix tool for managing multiple "virtual terminal windows" within a single ssh session.

- no need to ssh twice so you can have two terminals open at once
- processes executed from screen will continue to run after you log off (as long as you "detach" screen instead of closing it)

Command List

- `$ screen`
  - start screen
- **Ctrl-a + d**
  - "detach" screen session (procs. will continue to run)
- `$ screen -r`
  - "resume" prev. detached screen session
- **Ctrl-a + c**
  - "create" a new screen window
- **Ctrl-a + "**
  - view a list of currently open screen windows
- **Ctrl-a + [0-9]**
  - switch to screen window number 0-9