

100 points. Individual Work Only. Due **Feb 8, 2018** before class (**12:30 PM**).

**Objectives:**

- use a Linux system and command-line tools
- use a software version control system
- submit jobs through a batch system
- review a technical paper (optional for CS 432, required for CS 632 and CS 732)

**Instructions:**

**Part #1. Use a Linux system and command-line tools**

**Windows Users:**

1. Download and install PuTTY – a free SSH client. Download this from: <http://www.chiark.greenend.org.uk/~sgtatham/putty/latest.html>. Select the Windows Installer (putty-0.67-installer.msi), double click on the .msi file and follow the instructions to install in the directory of your choice. You can also create a shortcut on your desktop.
2. After you have successfully installed PuTTY, open the application, you will be prompted with a window to enter the Host Name, type *moat.cis.uab.edu*, and click on *Open* (you can also enter a session name, say CIS, under Saved Sessions and click on *Save*). You will be prompted to enter username and password, enter your blazerid and password. The first time you login you will see a popup, click OK. If successfully, you are now logged in to a CIS Linux system.

**Mac/Linux Users:**

1. Open the terminal application, you can find it under Applications -> Utilities -> Terminal.
2. Type *ssh <blazerid>@moat.cis.uab.edu*, make sure to replace *<blazerid>* with your individual *blazerid*. If this is your first login you will be prompted with the question “*Are you sure you want to continue connecting (yes/no)?*” type *yes* and then enter your password (blazerid password). If successful, you are now logged in to a CIS Linux system.

After successful login, you can now use Linux command-line tools to access various utilities and execute them. Here are couple of simple commands to try:

*pwd* – shows your current working directory  
*mkdir cs432* – creates a directory called “cs432”  
*cd cs432* – change directory to “cs432”  
*pwd* – shows the new working directory  
*mkdir hw1* – creates a directory called “hw1”  
*cd* – you are now back to the root of your home directory  
*pwd* – shows the current working directory  
*ls -lR* – recursively lists the files in long list format

## **Part #2. Compile and execute Homework-1 on a Linux system**

1. Copy the solution to Homework-1 to the CIS Linux system. On Windows systems, you can use the psftp tools that came with the PuTTY installation or use any other file transfer program such as sftp or WinSCP or FileZilla.  
On Mac/Linux systems, you can use *scp* from the terminal to copy files to the CIS Linux system. For example: *scp hw1.c <blazerid>@moat.cis.uab.edu:cs432/hw1/* will copy the local file *hw1.c* to the CIS Linux system in the directory *cs432/hw1/* (assuming you have already created these directories).
2. Login to the CIS Linux system and compile the solution to Homework-1 by typing “*gcc -O -o hw1 hw1.c*”
3. Execute the program by typing “*./hw1 100*”
4. If your program has any errors, fix that using a text editor such as *nano* or *vi*.

## **Part #3. Create a software repository to manage your source code**

1. Login to the CIS git server at <https://gitlab.cis.uab.edu> using your blazerid and password.
2. Create a new group (say, *parallel\_computing* or *cs432*) and add a new project (say, *hw1*) on the CS git server.
3. Login to the CIS Linux system and execute the following commands (assuming you have the solution as *hw1.c* in the directory *cs432/hw1* and the git group is *parallel\_computing* and project name is *hw1*):

```
cd cs432/hw1
git init
git remote add origin https://gitlab.cis.uab.edu/parallel_computing/hw1.git
git add hw1.c
git commit -m "Initial check in"
git push -u origin master
```
4. After this if you make changes to the file *hw1.c* you can update the repository using:

```
git commit -m "Appropriate commit message"
git push origin master
```

The URL above ([https://gitlab.cis.uab.edu/parallel\\_computing/hw1.git](https://gitlab.cis.uab.edu/parallel_computing/hw1.git)) will be different for you depending on your group and project names, you can get the URL by selecting HTTPS and clicking on the copy icon next to the URL on your project page on the git server.

#### **Part #4: Login to the dmc cluster at Alabama Supercomputing Center (ASC) and submit jobs**

1. Use an SSH client (as described in Part #1) and login to the *dmc* cluster (Host Name: *dmc.asc.edu*) at Alabama Supercomputing Center (ASC) using the username and password provided to you. First time you login, you will be prompted to change the password, please choose a secure password, and remember that password. Please review *Chapter 7. Accessing the Supercomputers* (pages 41–48) in HPC User Manual available on Canvas or the ASC website at <https://www.asc.edu/files/HPC-User-Manual>. If you are using Linux for the first time there is also a quick overview of using Linux systems in Chapter 8 (pages 60–89) of the user manual, please review that.
2. Edit the file *.bashrc.local.dmc* in the home directory and add “module load intel” to the end of that file (you have to use an editor such as *nano* or *vi* – see pages 80–87 of the user manual for more details). Logout and login again using the new password you selected.
3. Now that you have successfully logged in, check out the solution to homework-1 that you uploaded in Step #3, and compile it on the *dmc* cluster using the following commands:

```
git clone https://gitlab.cis.uab.edu/parallel_computing/hw1.git
cd hw1
icc -O -o hw1 hw1.c
```

The URL above will be different for you depending on your group and project names, you can get the URL by selecting HTTPS and clicking on the copy icon next to the URL on your project page on the git server.

4. Use an editor (e.g., *nano* or *vi* – see pages 80–87 of the user manual) and create a file called *myscript.sh* and add the following lines (assuming you named your executable *hw1*):

```
#!/bin/bash
./hw1 1000
./hw1 1000
./hw1 1000
```
5. Change the file permission for *myscript.sh* to have execute permissions using the following command:

```
chmod +x myscript.sh
```

6. Submit the job to the cluster using the following command:

```
run_script myscript.sh
```

You will be prompted with several questions, follow the sample session provided below (the options will be slightly different based on the queue selected). Make sure you choose the “class” queue, 1 core, and the appropriate maximum runtime and memory based on the problem size you are using. **Please do NOT execute programs on the login node, you MUST submit jobs to the batch system to execute your programs.**

```
-bash-4.2$ run_script myscript.sh
This runs a script in the current directory via the queue system
Report problems and post questions to the HPC staff (hpc@asc.edu)
```

**Choose a batch job queue:**

Queue	Wall Time	Mem	# Cores
express	4:00:00	16gb	1-4
small	60:00:00	4gb	1-8
medium	150:00:00	16gb	1-16
large	360:00:00	120gb	1-64
knl	60:00:00	94gb	1-256
benchmark	24:00:00	120gb	1-64
gpu	360:00:00	20gb	1-2

**Enter Queue Name (default <cr>: small)**

**Enter number of processor cores (default <cr>: 1 )**

**Enter Time Limit (default <cr>: 60:00:00 HH:MM:SS) 00:10:00**

**Enter memory limit (default <cr>: 1gb )**

The job name will be myscriptshSCRIPT (can be changed in .asc\_queue file)

Run on; uv, dmc, ivy-bridge, etc (default: any)  
dmc

```
=====
==== Summary of your script      job      =====
=====
```

```
The script file is: myscript.sh
The time limit is 00:10:00 HH:MM:SS.
The memory limit is: 1gb
The job will start running after: 2017-01-22T22:47:40
Job Name: myscriptshSCRIPT
Virtual queue: small
QOS: -p dmc,uv,knl --qos=small
Constraints: --constraint=dmc
Queue submit command:
sbatch -p dmc,uv,knl --qos=small -J myscriptshSCRIPT --begin=2017-01-
22T22:47:40 --requeue --mail-user=puri@cis.uab.edu -o
myscriptshSCRIPT.o%A -t 00:10:00 -N 1-1 -n 1 --mem-per-cpu=1000mb --
constraint=dmc
```

**Submitted batch job 66889**

7. You can check the status of your job using the “squeue” command. See the user’s manual for more details.

8. Once you are comfortable with using Linux and submitting the jobs, run the Game of Life program from Homework-1 on the dmc cluster and complete the table below.

Test Case #	Problem Size	Max. Generations	Time Taken HW1	Time Taken dmc cluster
1	1000x1000	1000		
2	5000x5000	1000		
3	5000x5000	5000		
4	10000x10000	1000		
5	10000x10000	5000		

Make sure you comment out any print statements you might have to print the board when you execute with larger problem sizes. Also, execute the program three times and use the average time taken. If your program creates large output files, please make sure you write the files to /scratch/\$USER directory. You have to first create the /scratch/\$USER directory using the command: mkdir /scratch/\$USER.

9. Compare the timing results from Homework-1 with the execution time on the dmc cluster. If there is difference in the execution time between the two runs, provide a rationale for this difference.

**Part #5: Review technical paper (optional for CS 432, required for CS 632 and 732)**

Read the paper titled “Exponential Laws of Computing Growth” by Peter J. Denning and Ted G. Lewis published in the January 2017 issue of Communications of ACM available at Canvas and answer the following questions in your report:

1. What is Moore's Law?
2. What is Dennard scaling?
3. What is S-curve model?
4. Is Moore's Law dead now?
5. According to the authors, what are the three levels of exponential growth in the computing ecosystem? Will this growth be sustained for the next decade?

**Report:**

Include the results from Part #4 along with the performance analysis and answers to questions in Part #5 in the report. Submit the report as a Word or PDF file.

**Submission:**

Upload the report (.doc or .pdf file) to Canvas in the assignment submission section for this homework. There is NO need to turn in any printed copies in class.

## Temporary Class Account Instructions

We have made an account for you on the machines at the Alabama Supercomputer Center. These systems are an SGI Ultraviolet, and a locally architected fat node cluster called a Dense Memory Cluster (DMC). Below is some information for new users of these machines. You can login, following the directions below, using the login and password provided by your instructor.

**WARNING: This is a temporary account. The account and all the files in it will be deleted at the end of the semester. You are responsible for keeping a copy of all your files before the semester ends.**

The best source of information on using these computers is the HPC User Manual, which can be accessed on the web at <https://www.asc.edu/files/HPC-User-Manual>. The command "ascdocs" shows a menu drive listing of locally written documentation. It displays text files, and gives paths for you to copy or download other types of files.

The computers can be accessed using secure shell (**SSH**). Secure shell is installed on many Linux and Unix machines, and can be called with a command like this

```
ssh UserID@uv.asc.edu  
ssh UserID@dmc.asc.edu
```

The first time you login, you will have to enter the password a second time, then set a new password. You will also be asked to enter an email address where error messages can be sent. This should be a complete email in the form myname@myschool.edu

Files can be copied to and from the DMC using secure copy "scp" or secure ftp "sftp". These programs are often included with secure shell software.

In order to get the maximum possible utilization of the computers, computational jobs are executed through the SLURM job queueing system. SLURM can be accessed via commands like "squeue" to check queue status.

A *run\_script* is provided for easily running jobs on the cluster. The *run\_script* will prompt you for the name of the queue and any limits you may wish to set on time, memory or file size. It then prompts for a date and time to run the job, job name, and output directory. All prompts can be satisfied by pressing "Enter" to give default values of the queue limits, immediate submittal, a default job name, and results being returned to the current directory. Only class accounts can submit jobs to the class queue.

Accounts have a disk quota limit. To see your disk quota, type "quota". Queue limits and interactive use limits can be seen by typing "qlimits".

If you need any help using the cluster or have questions about the cluster, **please post your questions on the discussion forum or contact the TA or course instructor first and do NOT contact the ASC staff directly.**