Brian.Moore@sdstate.edu University Networking and Research Computing (UNRC)

Overview

This is an outline document to help point users to information helping with basic Linux/UNIX command line skills and other information related to use of the SDSU shared-use servers. A few examples are given of frequently used commands; comprehensive references are given in the links. Special attention should be paid to the section on "Tracking usage–yours and others," because on a shared server your usage can impact on others.

Other sources of local documentation

To work through the examples here, you need an account on a Linux/UNIX system; the specific output shown here is from `blackjack`, the scheduler submit node of the main SDSU Linux cluster. Our link on the public SDSU website is http://www.sdstate.edu/technology/UNRC/Cluster/index.cfm. Information is provided there on how to get an account, and how to get logged in when you have your credentials, how to transfer files, etc.

More information on the cluster and UNRC is available on InsideState at https://insidestate.sdstate.edu/technology/infotech/Units/network-research/reference/. From this link, navigate to Research Computing and then the Documentation folder. The `bigjack_intro` document summarizes most of the information you need to get started.

To connect to the cluster and also InsideState, you need an sdstate network account (email ending in `sdstate.edu`). If you are having trouble accessing Insidestate, email brian.moore@sdstate.edu to receive documentation by email.

UNRC has a Listserv mailing list with periodic announcements for SDSU research server Linux users. One way to view the list is to go to http://lists.sdstate.edu/scripts and navigate to the UNRC_RESEARCHCOMPUTING list; you can view previous messages there, as well as subscribe to the list.

Linux command line information–online sources

Much information on UNIX/Linux command line skills is available via web search. Try queries such as "linux command line tutorial." Some links that have looked good to me are:

- http://linuxcommand.org/
- http://www.ee.surrey.ac.uk/Teaching/Unix/
- http://www.pixelbeat.org/cmdline.html
- http://community.linuxmint.com/tutorial/view/244

One can also find printable sources, of varying depth. For a short one, try Norm Matloff's excellent site, http://heather.cs.ucdavis.edu/~matloff/UnixAndC/Unix/UnixBareMn.pdf, or for for much more detail, the full-sized book at http://linuxcommand.org/tlcl.php.

Some initial commands to get started

Many of the initial commands to learn are related to navigating the file system using the command line: listing, creating, deleting, moving files, moving among subfolders, etc.

passwd

For “password.” One of the first things you should do when you first log in to the system is to change your password. Use the `passwd` command and it will first prompt you for your old password, then give you a chance to choose a new one.

man

The `man` command is short for manual. For many important commands, you can find more information by typing `man` followed by the command name, e.g. `man ls`.

ls

The `ls` command will list your files in the directory where your command prompt currently resides. The `ls` command alone will give a short listing; this command, like many UNIX commands has many options which can be invoked with a dash (see the man page for ls). Below is an example.

```
mooreb@blackjack:~/gsl> ls -al
total 3120
drwxr-xr-x   4 mooreb users    4096 2012-06-29 12:13 .
drwxr-xr-x 145 mooreb users   12288 2015-02-26 16:41 ..
drwxr-xr-x   6 mooreb users    4096 2012-06-29 12:13 1.14
drwxr-xr-x  52 mooreb users    4096 2012-06-29 12:12 gsl-1.14
-rw-r--r--   1 mooreb users 3163497 2012-06-29 11:58 gsl-1.14.tar.gz
mooreb@blackjack:~/gsl>
```

This is the subfolder gsl of my home directory, /home/mooreb. It contains two folders (1.14, and gsl-1.14) and one other file. When the `ls` command has finished execution, the system prompt reappears.

cd

For “change directory.” When you log in your system prompt is in your home directory, in my case `/home/mooreb`. In the example above, after I logged in, I gave the command `cd gsl` to move into the vmd folder.

pwd

For “print working directory,” It reports where your system prompt is currently located. For example:

```
mooreb@blackjack:~> pwd
/home/mooreb
mooreb@blackjack:~> cd gsl
mooreb@blackjack:~/gsl> pwd
/home/mooreb/gsl
mooreb@blackjack:~/gsl>
```

In the above example I start in my home folder, then changed to the `gsl` folder, using pwd to check where I am before and after the cd command.

mkdir

For “make directory.” Example:

```
mooreb@blackjack:~> mkdir testfolder
mooreb@blackjack:~> cd testfolder
mooreb@blackjack:~/testfolder> pwd
/home/mooreb/testfolder
mooreb@blackjack:~/testfolder> ls -al
total 16
drwxr-xr-x   2 mooreb users  4096 2015-03-03 10:43 .
drwxr-xr-x 146 mooreb users 12288 2015-03-03 10:43 ..
mooreb@blackjack:~/testfolder>
```

To remove a folder, the command is `rmdir`, but the folder must first be empty; see also the `rm` command to delete files.

cp

For “copy.” Always needs at least two arguments, source and target. Example:

```
mooreb@blackjack:~/gsl> cp gsl-1.14.tar.gz /home/mooreb/testfolder
mooreb@blackjack:~/gsl> cd ../testfolder
mooreb@blackjack:~/testfolder> ls
gsl-1.14.tar.gz
mooreb@blackjack:~/testfolder>
```

Notice that there is more than one way to specify a file’s path and name. If the file is in the folder where your system prompt is located (the location given by `pwd`) then you need only give the name of the file, as in the first argument above. If the file is in a different folder, you can specify an absolute path, such as `/home/mooreb/testfolder`, or a relative path, such as `../testfolder`. In the second case, the `..` is an abbreviation for the folder one level up from current.

For the `cp` command, if the last argument is a folder, all the preceding files are copied *into* the folder.

scp

For “secure copy” but more importantly *remote* secure copy. Similar to `cp` but either source or target is on another system. See Wikipedia article “Secure Copy.” Example: copying a file from blackjack to another system:

```
mooreb@blackjack:~> scp gsl/gsl-1.14.tar.gz mooreb@silvertip.jacks.local:
Password:
Password:
gsl-1.14.tar.gz                               100% 3089KB   3.0MB/s   00:00
mooreb@blackjack:~>
```

By default, the file will be copied to the top level folder of the user specified on the remote system. This can be modified by adding sub-folders on the remote end.

```
mooreb@blackjack:~> scp fdt.jar mooreb@silvertip.jacks.local:folder/subfolder
```

Of course you must know that these folders exist on the target.

When invoking the `cp` or `scp` command, if the target name is a folder, the file is put into the folder. If the target name does not exist, the file is copied and given the target name.

Note that both cp and scp have a recursive option, `-r`, that will operate on a folder instead of a file, and recursively copy the entire tree.

The example given in this section is copying between two Linux systems. You can also use scp to copy to/from a Windows system using a helper program like WinSCP. See the instructions at http://www.sdstate.edu/technology/UNRC/Cluster/upload/Windows-CLI-Instructions.pdf.

Command line completion

We can quickly type names like `gsl-1.14.tar.gz` and much longer with only a few keystrokes. Most Linux systems (including ours) have a command line completion feature, something like what you might do when texting on a cell phone. Type a few characters of the name, then hit the `tab` key, and it will complete with the longest string of unique characters possible.

There is a nice Wikipedia article on command line completion at http://en.wikipedia.org/wiki/Command-line_completion, with an animated gif image showing the process in action.

mv

For “move.” Syntax is similar to `cp`, i.e. it takes at least two arguments, but in this case the target (second argument) is replaced by the source (first argument); if the target is a folder, the source file/folder is put in that folder. If the target is a file, it is overwritten. `mv` is also used to rename files.

rm

For “remove.” The `rm` command will silently remove (delete) the file given after the command. Be careful! There is no “Trash” area; if you remove a file by mistake, you may not be able to get it back. Sometimes it is good to get in the habit of using the `-i` option with `rm`. Then it will prompt you first.

```
mooreb@blackjack:~/test2> ls
CationPi.pl  du_out.txt  report1
mooreb@blackjack:~/test2> rm -i report1
rm: remove regular file `report1'? y
mooreb@blackjack:~/test2>
```

rmdir

For “remove directory.” The target directory must be empty.

wildcards

The wildcard character `*` can be added to many of the previous commands. For example, my `example/sleep` folder has many files that begin with the string `sleep.pbs.o` (these are output files generated each time the program is run with the PBS scheduler).

```
mooreb@blackjack:~/examples/sleep> ls
sleep.pbs         sleep.pbs.e31744  sleep.pbs.o14647
sleep.pbs.e13760  sleep.pbs.e31745  sleep.pbs.o31744
sleep.pbs.e14647  sleep.pbs.o13760  sleep.pbs.o31745
mooreb@blackjack:~/examples/sleep>
```

To delete all files beginning with `sleep.pbs.o`:

```
mooreb@blackjack:~/examples/sleep> rm sleep.pbs.o*
mooreb@blackjack:~/examples/sleep> ls
sleep.pbs         sleep.pbs.e14647  sleep.pbs.e31745
sleep.pbs.e13760  sleep.pbs.e31744
mooreb@blackjack:~/examples/sleep>
```

Wildcards can be used in many different ways, and the case above is just a very simple example. For instance, `rm *.o*` would probably have also accomplished the same effect.

Be careful using wildcards with the `rm` command without the `-i` option!

more

Often you will want to view a plain text file. The simplest way is with the `cat` command (e.g. cat filename). But if the file is too long for the screen it will scroll off the top. Use the `more` command instead and you can scroll through it slowly. Type the q key to get out of the `more` pager. There are other pagers besides more. If you want to use a pager where you can scroll both down *and* up in the file, try the `less` pager.

Tracking usage–yours and others

When you log into blackjack, you have a session on the current login/submit node of the SDSU cluster. As such we ask users to keep any processes they run on blackjack short (not more than a few minutes) and not too demanding in terms of CPU and RAM. You can test small instances of your jobs on blackjack, but then when it comes time to run them longer/bigger, use the PBS scheduler submit sytem to deploy the job to a node of the cluster. If you want to run longer interactive jobs, not on a node, you can use our test/development node, flapjack, or we can get you an account on one of the non-cluster servers.

Hence, when running on any of the SDSU Linux servers, it is very important to keep track of your own use and others of shared resources. The main categories to watch are disk, cpu and RAM.

df

For "disk free." It will report the usage on all mounted file systems. I like using the `-h` option to get output in "human" terms (MB, GB).

```
mooreb@blackjack:~> df -h
Filesystem           Size  Used Avail Use% Mounted on
/dev/sda2            266G  4.2G  249G   2% /
udev                  24G  164K   24G   1% /dev
tmpfs                 24G     0   24G   0% /dev/shm
bigjack:/home/       9.9T  8.3T  1.2T  89% /home
bigjack:/shared      266G  179G   75G  71% /shared
bigjack:/sdsustor50  4.0T  1.8T  2.0T  47% /sdsustor50
bigjack:/scratch     5.0T  847G  3.9T  18% /scratch
mooreb@blackjack:~>
```

One thing to take notice of especially is the usage on `/home`, as that is where all the users' home folders are located. If you see /home filling up send an email to me and/or Bryan Rieger. The scratch area is for short-term storage for jobs about to run, currently running, or recently finished. If you need more space to run a job requiring large disk, email a request and we will create a folder for you on `scratch`.

du

For "disk usage." It will report the usage of every subfolder of the current folder, and give a grand total at the end. Keep an eye on your usage. The `-h` switch gives the output in "human" terms (default is kB).

```
28K     ./Xtest
8.0K    ./python3/lib/pkgconfig
220K    ./python3/lib/python3.3/collections/__pycache__
292K    ./python3/lib/python3.3/collections
908K    ./python3/lib/python3.3/unittest/test/__pycache__
596K    ./python3/lib/python3.3/unittest/test/testmock/__pycache__
764K    ./python3/lib/python3.3/unittest/test/testmock
[Lots of output deleted]
12K     ./.cpanm/work/1422634306.9881/Acme-Time-Baby-2010090301/blib/meta
4.0K    ./.cpanm/work/1422634306.9881/Acme-Time-Baby-2010090301/blib/man1
4.0K    ./.cpanm/work/1422634306.9881/Acme-Time-Baby-2010090301/blib/bin
104K    ./.cpanm/work/1422634306.9881/Acme-Time-Baby-2010090301/blib
272K    ./.cpanm/work/1422634306.9881/Acme-Time-Baby-2010090301
292K    ./.cpanm/work/1422634306.9881
296K    ./.cpanm/work
300K    ./.cpanm
188G    .
```

quota

The cluster uses a disk quota system.

```
mooreb@blackjack:~> quotac
Disk quotas for user mooreb (uid 1004):
     Filesystem  blocks   quota   limit   grace   files   quota   limit   grace
      /dev/sdc1 195091680  250000000 250000000          402547       0       0
mooreb@blackjack:~>
```

The units are blocks; 1000 blocks 1 MB. To get GB, divide by 10^6 or take away 6 digits from the right. This reads (roughly) 195 GB used, and 250 GB quota.

top

The `top` command gives you an ongoing updated screen of all processes, sorted by cpu usage. To exit from top, hit the q key.

```
top - 11:01:58 up 2 days,  1:06,  3 users,  load average: 0.00, 0.01, 0.05
Tasks: 186 total,   1 running, 185 sleeping,   0 stopped,   0 zombie
Cpu(s):  0.0%us,  0.0%sy,  0.0%ni,100.0%id,  0.0%wa,  0.0%hi,  0.0%si,  0.0%st
Mem:     48388M total,     9528M used,    38860M free,       80M buffers
Swap:     2053M total,        0M used,     2053M free,     8585M cached

  PID USER      PR  NI  VIRT  RES  SHR S   %CPU %MEM    TIME+  COMMAND
  120 root      20   0     0    0    0 S      0  0.0   0:02.22 kworker/3:1
10865 mooreb    20   0  8928 1220  848 R      0  0.0   0:00.01 top
    1 root      20   0 10548  836  704 S      0  0.0   0:01.42 init
    2 root      20   0     0    0    0 S      0  0.0   0:00.00 kthreadd
    3 root      20   0     0    0    0 S      0  0.0   0:00.49 ksoftirqd/0
    4 root      20   0     0    0    0 S      0  0.0   0:00.01 kworker/0:0
    6 root      RT   0     0    0    0 S      0  0.0   0:00.03 migration/0
[Rest of output deleted]
```

This is a typical output for blackjack; very little is running that shows up on cpu. If someone is running a process that creates a load, it will show up, near the top, if the cpu usage is high. To demonstrate, I ran an example, two core, cpu-intensive process:

```
top - 14:39:53 up 24 days, 22:36,  2 users,  load average: 1.93, 0.98, 0.42
Tasks: 232 total,   3 running, 229 sleeping,   0 stopped,   0 zombie
Cpu(s):  8.3%us,  0.0%sy,  0.0%ni, 91.6%id,  0.0%wa,  0.0%hi,  0.0%si,  0.0%st
Mem:     48260M total,     2125M used,    46135M free,      139M buffers
Swap:     6147M total,        0M used,     6147M free,     1070M cached

  PID USER      PR  NI  VIRT  RES  SHR S   %CPU %MEM    TIME+  COMMAND
24668 mooreb    20   0  181m 6540 3140 R    100  0.0   3:11.17 prime_mpi
24669 mooreb    20   0  181m 6464 3076 R    100  0.0   3:11.21 prime_mpi
 4916 root      20   0  6712  664  384 S      0  0.0  11:25.19 irqbalance
24747 mooreb    20   0  9076 1228  828 R      0  0.0   0:00.01 top
[Rest of output deleted]
```

In this case, you can see that I am running two cpu intensive processes on blackjack. Since there are a total of 12 processor cores, it is not “full” in terms of cpu load yet. Again, we remind users to only run short test jobs on blackjack itself. More demanding jobs should be run on the nodes using the scheduler.

You can change the sort on top by using the > (Shift-comma) or < (Shift-period) keys. Remember that you start on the CPU column by default. For example, after bringing up top, then hitting the > key once, you will be sorting on memory.

Running a command in background, input and ouput redirect, etc.

Compiling a simple C program

To illustrate running in background, etc., I have provided a very simple single-threaded example program on the cluster called `prime_ex` that does a prime number search. The files should be located in my home folder underneath the examples subfolder, i.e. in `/home/mooreb/examples/C`.

copying the example code

To compile the program yourself, you have to first copy the C source code into your home folder or a subfolder you create. For example as below:

```
mooreb@blackjack:~> mkdir testprogram
mooreb@blackjack:~> cd testprogram
mooreb@blackjack:~/testprogram> cp /home/mooreb/examples/C/prime_ex.c  .
mooreb@blackjack:~/testprogram> ls
prime_ex.c
mooreb@blackjack:~/testprogram>
```

compiling the program

For this simple C program, use the gcc compiler:

```
gcc prime_ex.c
```

This will create an executable file named `a.out`. You can rename `a.out` to whatever you like (using `mv`), or you can add an option `-o` in the compile to explicitly name the executable created by the compile.

This just scratches the surface–this is only the very simplest of compile for one example language, C. For other languages, or programs that require linking to libraries, or large complex programs, many more options are available.

Running a program on the command line interactively

We will use the `prime_ex` program as an example for running interactively. The program computes all the prime numbers less than or equal to a given input number and writes back one line with the number of primes found. So this particular program takes as input interactively one integer number. To run this program for a small argument, from the command line:

```
mooreb@blackjack:~/testprogram> ./a.out
Enter nmax:
100
Input nmax = 100
The number of primes less than or equal to 100 is 25
mooreb@blackjack:~/testprogram>
```

The program is written to write the prompt and wait for input. Then when it receives the number and the user hits return, the program runs and the output is written to the screen.

(Btw, to check if the program is correct, see for example http://primes.utm.edu/howmany.shtml).

This program runs instantaneously when the input is 100; we can make that number bigger and bigger and eventually it will take a while to compute. So this is a small example of a program that would be useful to run in background (and, eventually, on a worker node, not blackjack itself).

input redirect

Our very simple `prime_ex` program does not take much in input, just one int, but some programs take very large input sets, so that it is inconvenient to type them all on the command line. You can put your inputs in a file and then redirect the file to the program as input.

To create an input file you can use an editor (see the section on Linux/UNIX editors) or you can just do:

```
echo "1000" > infile
```

and it will create a textfile called `infile` with just the given echoed characters in it. Then use this as input redirect:

```
./a.out < infile
```

output redirect

You will notice that when we run with input redirect, it still writes the output to the screen. We can make that output go to a file instead with an output redirect.

```
./a.out < infile &> outfile
```

Then you can use the `more` command to check the contents of the output file.

Note that output redirect does not have to be combined with putting the job in background. For example `ls -al /home > lsfile` will put what would have been produced by `ls -al` (a long listing of `/home`) into the file `lsfile`; in this case there is no point of putting the job in background since it runs so fast.

Running a program in background

Running from the command line is no problem if the program finishes right away, but what if you want to run a program that takes a long time? You don't want it to hold up the terminal. For our example program, you can try slowly ramping up the value of your input integer and you will see it start to take time to finish. How long depends on system load. I found somewhere around 500000 it started to have a noticeable delay.

```
mooreb@blackjack:~/testprogram> echo "500000" > infile
mooreb@blackjack:~/testprogram> ./a.out < infile &> outfile
```

Now it just sits there, with the terminal held up, until it finishes. If you hit Ctrl-C the program will terminate.

You can start a program and put it in background by appending the ampersand symbol, `&`, after the program name and inputs.

```
mooreb@blackjack:~/testprogram> ./a.out < infile &> outfile &
[1] 11220
mooreb@blackjack:~/testprogram>
```

Now it responds with a number for the process and puts you back to the system prompt. While the program is running, the terminal is freed up for new commands for you to type while the program is running. If it is a very long process, you can even log off and it will still run in background. When the program is done, it will write to the redirected output file, just as before.

Note the response when you put the job in background; two numbers. The first, `[1]`, is the number of the process in terms of background processes attached this terminal. The second one, `11220` is the process ID (PID) on the system in general.

Killing a process

You can kill a process with the `kill` command. The most general way is to know the PID number associated with the process (e.g. the number 11220 above, shown when put in background). If you don't know the PID of your process you want to kill, you can use the `top` command to try and find it. To limit the output of top, you can use the `-u` option, which restricts the display to a named user, e.g. `top -u mooreb`.

Piping command output to another command

You can send the output of any commands that produces text into another appropriate command. For example, if you were to list all the entries in /home, long listing you would use `ls -al /home`. You notice that the entries are too many for the screen. So instead use:

```
ls -al /home | more
```

and it will display the output through the `more` pager. This is just one simple example of piping! It can get much more detailed and complicated if necessary.

Using a simple text editor in the terminal

You will usually need to be able to perform some simple text editing on your input or other files on the system. Here we will take as an example copying a basic simple PBS script and editing it to add the command to our simple, single-core, prime number finder.

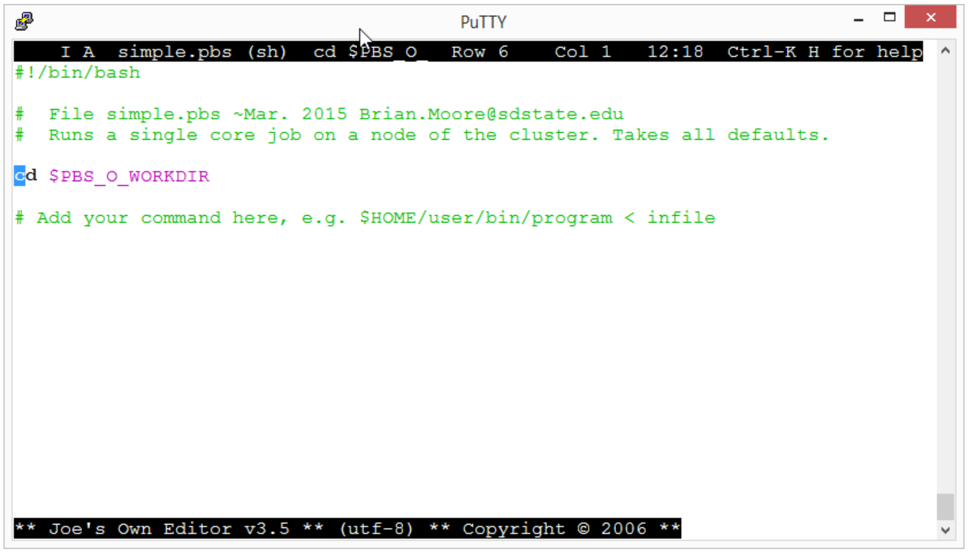
Working with this same example, we had the program in a folder beneath the home directory called testfolder. Copy a simple PBS script into that folder:

```
mooreb@blackjack:~> cp /home/mooreb/examples/simple/simple.pbs testprogram/
mooreb@blackjack:~> cd testprogram
mooreb@blackjack:~/testprogram> ls
a.out  infile  outfile  prime_ex.c  simple.pbs
mooreb@blackjack:~/testprogram>
```

Now, open the file `simple.pbs` in a text editor. We chose the joe editor because it is simple, but you can use vi if you are familiar with it also.

```
mooreb@blackjack:~/testprogram> joe simple.pbs
```

You should see something like the following:



```
    I A  simple.pbs (sh)  cd $PBS_O_   Row 6    Col 1   12:18  Ctrl-K H for help
#!/bin/bash

#  File simple.pbs ~Mar. 2015 Brian.Moore@sdstate.edu
#  Runs a single core job on a node of the cluster. Takes all defaults.

cd $PBS_O_WORKDIR

# Add your command here, e.g. $HOME/user/bin/program < infile

** Joe's Own Editor v3.5 ** (utf-8) ** Copyright © 2006 **
```

Figure 1: image

At this point you can move the cursor around with the arrow keys and type text or delete characters, etc. I don't use joe frequently, but the only thing I need to know is always right on the screen, top right: Ctrl-K H for help. If you hit those keys it will bring up a few lines of help. Repeating Ctrl-K H will make the help menu disappear.

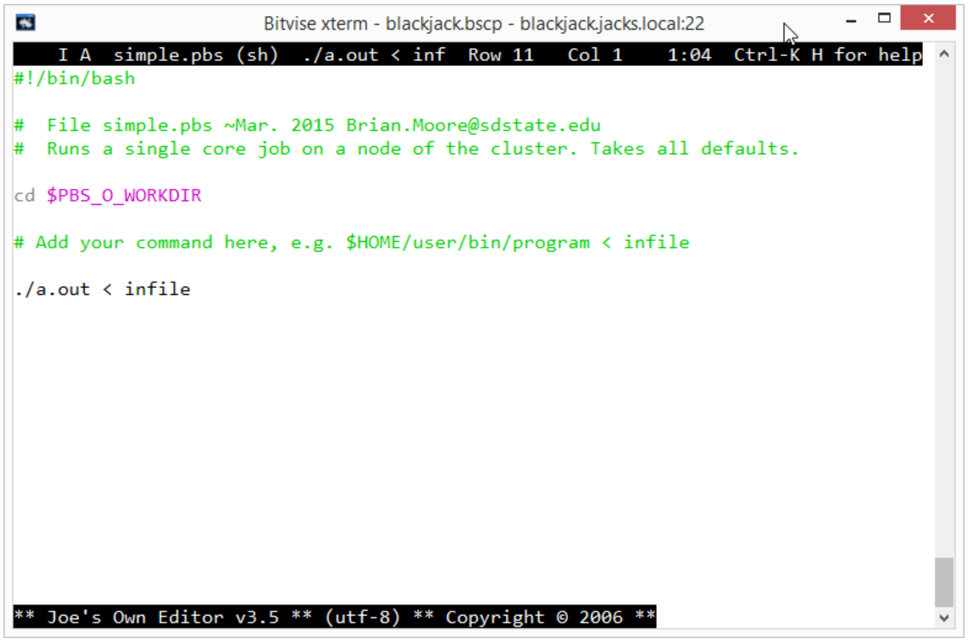
Here we want do to just a simple edit: add the line to run our program. So, position your cursor on a line below the last line (lines beginning with # are comments) and type:

```
./a.out < infile
```

When you are done, the screen should look something like:

Then use Ctrl-K X to save the file. Once you have the editor closed, you can use the `more` command to check the contents and make sure the edit was done how you wanted.

Why did we not use the exact command we had used on the command line, which was `./a.out < infile &> outfile &`?



```
    I A  simple.pbs (sh)  ./a.out < inf  Row 11   Col 1    1:04  Ctrl-K H for help
#!/bin/bash

#  File simple.pbs ~Mar. 2015 Brian.Moore@sdstate.edu
#  Runs a single core job on a node of the cluster. Takes all defaults.

cd $PBS_O_WORKDIR

# Add your command here, e.g. $HOME/user/bin/program < infile

./a.out < infile
```

```
** Joe's Own Editor v3.5 ** (utf-8) ** Copyright © 2006 **
```

Figure 2: image

First, you *don't* want to put your job in background in the scheduler script as it defeats the whole point of the scheduler. When we run on the node, using PBS, you will see the job is automatically put in a batch mode, so there is no reason to put it in background.

Second, the scheduler will automatically produce an output file, so we don't need to re-direct the output. We could, but for such a small job, here there is no need.

Submitting a PBS script

Note that we have a separate set of documentation with more detail on how to use the Moab/PBS scheduler. The section here is just to get you started on a very simple example.

Now, if we are in the folder that has the submit script, and the program, and the input file, we use the `qsub` command to submit the job.

```
mooreb@blackjack:~/testprogram> qsub simple.pbs
32873.bigjack
```

It responds with a number, which is our job number. Assuming the job does not finish immediately, we can use some helper commands to check on the status. The `qstat` command will show our currently running (or recently ended) jobs.

```
mooreb@blackjack:~> qstat
Job ID                    Name             User            Time Use S Queue
------------------------- ---------------- --------------- -------- - -----
32873.bigjack              simple.pbs       mooreb                 0 R batch
```

This does not seem to tell us much, but the most important thing to note is the "R" underneath the S (for status), which means the job is running. Other commonly seen codes are C (Complete), E (error) or Q (queued).

To see all the jobs running in the scheduler you can use `showq`:

```
mooreb@blackjack:~> showq

active jobs------------------------
JOBID              USERNAME      STATE PROCS   REMAINING            STARTTIME

32873                mooreb    Running     1    00:59:42  Thu Mar  5 12:52:33
32842                nagele    Running    12  5:20:52:00  Wed Mar  4 09:44:51
32843                nagele    Running    12  5:20:52:30  Wed Mar  4 09:45:21

3 active jobs            25 of 732 processors in use by local jobs (3.42%)
                           3 of 61 nodes active      (4.92%)
```

Here we see our job running, having been listed as asking for one process (the default). Note the time remaining, just nearly an hour; that is because our walltime limit was the default of one hour, and we've used just a little bit of it.

Now, if all goes well and the job finishes, you should have two new files in your folder:

```
mooreb@blackjack:~/testprogram> ls
a.out   outfile     simple.pbs   simple.pbs.e32873
infile  prime_ex.c  simple.pbs~  simple.pbs.o32873
mooreb@blackjack:~/testprogram>
```

The two new files have the name of the script, appended by the job number preceded either by the character `o` (for output) or `e` for error.

Use `more` to look inside the output file.

```
mooreb@blackjack:~/testprogram> more simple.pbs.o32873
Enter nmax:
Input nmax = 500000
The number of primes less than or equal to 500000 is 41538
mooreb@blackjack:~/testprogram>
```