Student will work with process management and some basic system calls.

**UNIX Shell**

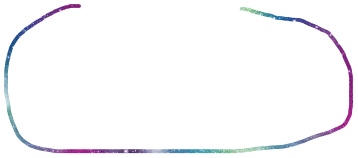
In Lab9 we did the 3 built-in commands: cd, pwd, exit.

Now we need to implement: a fork, an exec, and code to handle redirection.

**Makeshift Pictorial of the calling sequence of Lab10**

**main/lab10.c** Box indicates a function.

**ParseCmd RunExtCmd**

** Call fork**

**Parent does Wait Child Process**

***ProcessCmd***

** Redirection**

**Call execvp**

**FILES TO COPY- Different Instructions this time**:

To get the files you need, first move to your class folder by typing: **cd csc60**

Type: **cp -R /home/college/bielr/files\_csc60/lab10 .**

Spaces needed: (1) After the **cp ↑** Don’t miss the space & dot.

(2) After the **-R**

(3) After the directory name at the end & before the dot.

You have now created a lab10 directory and copied in Lab10 functions:

No lab10.c since you will add code to your renamed lab9.c

**~~lab10.c~~, ParseCmd.c**, **RunExtCmd.c**, **lab9\_10.h**,

**ProcessCmd.c** (to be completed by you), (You create **Redirection.c** yourself.)

You have also copied in three sample files that may be helpful to you:

execvp.c, redir.c, waitpid.c

**🡪 *more on next page***

Stay in directory **csc60**, and you need to

type: **chmod 755 lab10**

type: **cp lab9/lab9.c lab10/lab10.c //new command**

We have copied lab9 code and renamed it to lab10.c for you to start work on it.

Next move to **lab10** directory by typing: **cd lab10**

and type: **chmod 644 \***

This will set permissions on all the files.

Your new lab10 directory should now contain:

**lab10.c**, **ParseCmd.c**, **RunExtCmd.c**, **lab9\_10.h**,

**ProcessCmd.c** (to be completed by you), (You create **Redirection.c** yourself.)

The small files: *waitpid.c, redir.c*, and *execvp.c*, contain code examples that may help you in completing Lab10. They are just bits of sample code, not to be directly copied into the code that is assigned to you.

**EDITING COMMENTS**: Some code to be used in Lab10 is currently commented out. You need to remove some comments as directed below.

1. Move to your lab10 directory.

Type: **vim lab10.c**

Edit the first comment lines to change lab9 to lab10.

Go to the end of the file. About 4 lines from the end, is the call to RunExtCmd.

Remove the // from the beginning of that function call.

It will now be: RunExtCmd(argc, argv);

Save the file.

1. Type: **vim lab9\_10.h**

The last lines of the file look like this:

/\* function prototypes \*/

int ParseCmd(char \*CmdLine, char \*\*argv);

\_\_

//The three function prototypes below will be needed in lab10.

//Leave them here to be used later.

// void ProcessCmd(int argc, char \*\*argv);

// void Redirection(int argc, char \*\*argv);

// void RunExtCmd(int argc, char \*\*argv);

Change the lines to look like the 5 lines just below:

/\* function prototypes \*/

int ParseCmd(char \* CmdLine, char \*\*argv);

void ProcessCmd(int argc, char \*\*argv);

void Redirection(int argc, char \*\*argv);

void RunExtCmd(int argc, char \*\*argv);

Save the file. (Side Note: **char \*argv[]** does the same thing as **char \*\*argv**)

**Pseudo Code** (Yellow highlight on the pseudo code indicates the code from Lab9.)

/\*----------------------------------------------------------\*/

int main (void)

{

while (TRUE)

{

print the prompt(); /\* *i.e.* ***csc60mshell* >** , Use printf\*/

fgets(cmdline, MAXLINE, stdin);

/\* You have to write the call. The function itself is *provided:* function ParseCmd \*/

Call the function ***ParseCmd***, sending in **CmdLine** & **argv**, getting back **argc**

/\* code to print out the argc and the argv list to make sure it all came in. Required.\*/

Print a line. Ex: “Argc = %i”

loop starting at zero, thru less than argc, increment by one.

print each argv[loop counter] [("Argv %i = %s \n", i, argv[i]);]

/\* Start processing the built-in commands \*/

if ( argc compare equal to zero)

/\* a command was not entered, might have been just Enter or a space&Enter \*/

*continue* to end of while(TRUE)-loop

// next deal with the built-in commands

// Use *strcmp* to do the test

// after **each** command, do a *continue* to end of while(TRUE)-loop

if (“exit”)

issue an exit call

else if (“pwd”)

declare a char variable array of size MAX\_PATH\_LENGTH to hold the path

do a getcwd

print the path

else if (“cd”)

declare a char variable *dir* as a pointer (with an \*)

if the argc is 1

use the getenv call with “HOME” and

return the value from the call to variable *dir*

else

variable *dir* gets assigned the value of argv[1]

execute a call to chdir(dir) with error checking. Message = “error changing directory”

else /\* fork off a process. \*/

{ 🡪 the rest on next page

RunExtCmd(argc, argv);

} /\* end of if-else-if that starts with: if “EXIT”

} /\* end of the while(TRUE)-loop

} /\* end of main

void **RunExtCmd**(int argc, char \*\* argv) //PROVIDED TO YOU

{ int status;

pid\_t pid:

pid = fork();

switch(pid)

{

case -1:

perror(“Fork error”);

exit(EXIT\_FAILURE);

case 0:

// I am the child process. I will execute the call to *execvp*

**ProcessCmd**(argc, argv);

break;

default:

// I am the parent process.

if(wait(&status) == -1)

perror (Error on the parent wait);

else

printf(“Child returned status: %d\n”, status);

break;

} /\* end of the switch \*/

return;

}

**void ProcessCmd (int argc, char \*\*argv)** // You add code to complete this function.

// Child Process

// Put this in its own file.

{

call **Redirection** passing it *argc* and *argv* //(Don’t need any \* on argv)

call **execvp** passing in *argv[0]* and *argv* and return a value to an *integer* variable

(Example of int variable: *ret*)

if (*ret* == -1)

error check and \_exit(EXIT\_FAILURE)

}

**void Redirection(int argc, char \*argv[])** *//Remember to include Your Name.*

*//You write this function in its own file. //Include the file* ***lab9\_10.h***

// This function is a Child Process so use **\_exit**.

//You need two integer variables to keep track of the ***location*** in the string of the

// redirection symbols, (one for **O*utLoc*** (>), one for ***InLoc*** (<) ). Initialize them to **zero**.

// When I use the words *loop* or *loop counter,* I am referring to whatever variable (i) you use

// in your loop.

{ grey is legal; yellow is illegal

***for*** loop from 0 to < *argc*

if ( “>” == 0) // use strcmp function *ls > lsout > file1*

if ***OutLoc*** not equal 0 *0 1 2 3 4*

Cannot output to more than one file. fprintf error. \_exit failure.

else if loop\_counter compares equal 0 ?? *> lsout*

No command entered. fprintf error. \_exit failure. *0 1*

set **O*utLoc*** to the current loop\_counter.

else if (“<” == 0) // use strcmp function *wc < lsout < file1*

if ***InLoc*** not equal 0 *0 1 2 3 4*

Cannot input from more than one file. fprintf error. \_exit failure.

else if the loop\_counter compares equal 0

No command entered. fprintf error. \_exit failure. *?? < lsout*

set ***InLoc*** to the current loop\_counter. *0 1*

// end of the **if -else if**

// end of the **for** loop

if(***OutLoc*** != 0)

if **argv** (indexed by ***OutLoc*** +1) contains a NULL *ls > NULL*

There is no file, so *fprintf* an error, and *\_exit* in failure. *0 1 ??*

**Open** the file using name from ***argv***, indexed by ***OutLoc***+1, *ls > lsout*

and assign returned value to ***fd***. [See 9-Unix, slides 6-10] *0 1 2*

use **flags**: to read/write; to create file if needed;

to truncate existing file to zero length

use **permission** bits for: user-read; user-write

Error check the **open**. *perror* & *\_exit*

Call **dup2** to switch *standard-out* to the value of the file descriptor.

**Close** the file

Set things up for the future exec call by setting ***argv*[*OutLoc*]** to NULL

// end of if(***OutLoc***!= 0)

*wc < lsout > wcout*

if(***InLoc*** != 0)

if **argv** (indexed by ***InLoc*** +1) contains a NULL

There is no file, so *fprintf* an error, and *\_exit* in failure.

**Open** the file using name from ***argv***, indexed by ***InLoc***+1

and assign returned value to ***fd***. Use flag; for read only

Error check the open. *perror* & *\_exit*

Call **dup2** to switch *standard-in* to the value of the file descriptor.

**Close** the file

Set things up for the future exec call by setting ***argv*[*InLoc*]** to NULL

//end of if(***in*** != 0)

Word of warning: In the past many students have duplicated the code for OpenOutputFile section to be used for OpenInputFile section. If you do that, lots of little things need to be changed. Be careful.

**Resources**

### **Useful Unix System Calls:** Also see PowerPoint Slides file named **Lab10 Slides**

**C Library functions:**

|  |
| --- |
| #include <string.h>  *String compare:*  int strcmp(const char \*s1, const char \*s2); //Function prototype from string.h    **if(strcmp(argv[0], "exit") == 0) //Sample.** One line completed.  strcmp(argv[0],"pwd")  strcmp(argv[0],"cd")  strcmp(….,">") **//Sample**. **if(strcmp(argv[i], “>”) == 0)**  strcmp(….,"<")  *print a system error message:*  perror("Shell Program error \n"); |

**Compilation & Building your program**

You need to write a **makefile** to pull all the program files and functions together.

Remember to add a make-type comment of your name.  **#**name

All code files that are student-modified should include a comment with your name.

The function Redirection.c **must** be in its own file, and NOT in lab9\_10.h

In your code, you **must** use the function names given in the Algorithm.

In the function Redirection, you **must** use the function names and variable names given in the Algorithm, with the exception of loop counter variable names.

**Partnership**

Students may form a group of 2 students (maximum) to work on this lab. As usual, please always contact your instructor for questions or clarification. Your partner does not have to attend the same section but must in one of the four sections taught by Prof. Biel.

All code files that are student-modified should include both names.

Using **vim**, create a small name file with both of your names in it. When you start your script file, *cat* that name file so both names show up in the script file.

**You must BOTH submit the same code and script**. Each of these files will include both of your names.

As both of your names occur on everything, when I or another grader find the first submission, we will then give the same grade to the second student.

**Hints**

*Our compiler does not like:* **for (int i = 0; …..)**

You will receive the following errors:

test\_loopcounter.c:6: error: ‘for’ loop initial declarations are only allowed in C99 mode

test\_loopcounter.c:6: note: use option -std=c99 or -std=gnu99 to compile your code

These errors imply that on every “gcc” line, you must add: **-std=c99** OR -std=gnu99.

*It does like it on two lines:*

**int i;**

**for (i = 0; ……)**

Keep versions of your code. This is in case you need to go back to your older version due to an unforeseen bug/issue.

You should NOT make any changes in functions: ParseCmd.c, RunExtCmd.c

You should only make changes in these functions as indicated in the directions:

lab9\_10.h, ProcessCmd.c, lab10.c

**Points Value**

Lab 10 is worth 85 points.

**Preparing your script file:**

Be in **csc60/lab10** directory. When all is well and correct,

type: **script name\_lab10.txt**

*If you are on a team,* **cat *your name file here****.*

At the prompt, type: **touch lab9\_10.h**

type: **make**

type: ./**lab10** to run the program (or whatever name you used)

Enter in sequence:

1. ls > lsout // should work with output going to file
2. cat lsout // display the contents of the output file
3. ls > lsout > file1 // should produce an error

5. cat foo.txt // should produce an error

6. > lsout // should produce an error

7. < lsout // should produce an error

// ***wc*** *prints newline, word, and byte counts for each file*

8. wc < lsout // output will go to the screen.

9. wc < lsout > wcout // output will go to a file

10. cat wcout // display the output

11. wc < lsout < wcout // should produce an error

12. cd ../lab1 // move to lab1 directory

13. gcc lab1.c // show that the exec works

14. a.out // show output of lab1 or…. ./a.out or ./lab10

15. exit // (exit from the shell)

16. exit // (exit from the script)

**Deliverables**

Submit **six** files to Canvas**. Please no zip files on Canvas.**

1. makefile
2. lab9\_10.h
3. ProcessCmd.c
4. lab10.c
5. Redirection.c
6. lab10.txt (the script file)