UNIX Shell and History Feature
100 points

Due: Wednesday, October 18, 11:59pm

This project consists of designing a C program to serve as a shell interface that accepts user commands and then executes each command in a separate process. This project can be completed on any Linux, UNIX, or Mac OS X system.

A shell interface gives the user a prompt, after which the next command is entered. The example below illustrates the prompt osh> and the user's next command: cat prog.c. (This command displays the file prog.c on the terminal using the UNIX cat command.)

```
osh> cat prog.c
```

One technique for implementing a shell interface is to have the parent process first read what the user enters on the command line (in this case, cat prog.c), and then create a separate child process that performs the command. Unless otherwise specified, the parent process waits for the child to exit before continuing. This is similar in functionality to the new process creation illustrated in Figure 3.10 of textbook. However, UNIX shells typically also allow the child process to run in the background, or concurrently. To accomplish this, we add an ampersand (&) at the end of the command. Thus, if we rewrite the above command as

```
osh> cat prog.c &
```

the parent and child processes will run concurrently.

The separate child process is created using the fork() system call, and the user's command is executed using one of the system calls in the exec() family.

A C program that provides the general operations of a command-line shell is supplied in Figure 3. The main() function presents the prompt osh-> and outlines the steps to be taken after input from the user has been read. The main() function continually loops as long as should_run equals 1; when the user enters exit at the prompt, your program will set should_run to 0 and terminate.

This project is organized into two parts:

(1) creating the child process and executing the command in the child, and

(2) modifying the shell to allow a history feature.

```
#include <stdio.h>
#include <unistd.h>

#define MAX_LINE 80 /* The maximum length command */

int main(void)
{
char *args[MAX_LINE/2 + 1]; /* command line arguments */
int should_run = 1; /* flag to determine when to exit program */

   while (should_run) {
      printf("osh>");
      fflush(stdout);

      /**
       * After reading user input, the steps are:
       * (1) fork a child process using fork()
       * (2) the child process will invoke execvp()
       * (3) if command included &, parent will invoke wait()
       */
   }

    return 0;
}
```

Figure 3 Outline of simple shell.

Part I— Creating a Child Process

The first task is to modify the `main()` function in Figure 3 so that a child
process is forked and executes the command specified by the user. This will
require parsing what the user has entered into separate tokens and storing the
tokens in an array of character strings (`args` in Figure 3). For example, if the
user enters the command `ps -ael` at the `osh>` prompt, the values stored in the
`args` array are:

```
args[0] = "ps"
args[1] = "-ael"
args[2] = NULL
```

This `args` array will be passed to the `execvp()` function, which has the
following prototype:

```
execvp(char *command, char *params[]);
```

Here, `command` represents the command to be performed and `params` stores the
parameters to this command. For this project, the `execvp()` function should
be invoked as `execvp(args[0], args)`. Be sure to check whether the user
included an & to determine whether or not the parent process is to wait for the
child to exit.

Part II—Creating a History Feature

The next task is to modify the shell interface program so that it provides a *history* feature that allows the user to access the most recently entered commands. The user will be able to access up to 10 commands by using the feature. The commands will be consecutively numbered starting at 1, and the numbering will continue past 10. For example, if the user has entered 35 commands, the 10 most recent commands will be numbered 26 to 35.

The user will be able to list the command history by entering the command

```
history
```

at the `osh>` prompt. As an example, assume that the history consists of the commands (from most to least recent):

```
ps, ls -l, top, cal, who, date
```

The command `history` will output:

```
6 ps
5 ls -l
4 top
3 cal
2 who
1 date
```

Your program should support two techniques for retrieving commands from the command history:

1. When the user enters `!!`, the most recent command in the history is executed.

2. When the user enters a single `!` followed by an integer N, the Nth command in the history is executed.

Continuing our example from above, if the user enters `!!`, the `ps` command will be performed; if the user enters `!3`, the command `cal` will be executed. Any command executed in this fashion should be echoed on the user's screen. The command should also be placed in the history buffer as the next command.

The program should also manage basic error handling. If there are no commands in the history, entering `!!` should result in a message "No commands in history." If there is no command corresponding to the number entered with the single `!`, the program should output "No such command in history."

Extra Credit

In addition to the 100 points for project 1, you can earn extra credit by doing one or both of the following tasks:

1. **Handling Multiple Commands**   **10 points**

The simple command-line shell interface provided in Figure 3 can handle one command per line only, whereas, in actual linux shell multiple commands can be entered in a line separated by ";", like

-bash-4.3$ date;cal;who

with the following **output**:

Wed Sep 13 12:55:51 CDT 2017

September 2017
Su Mo Tu We Th Fr Sa
                1 2
 3 4 5 6 7 8 9 10 11
12 13 14 15 16 17 18 19
20 21 22 23 24 25 26 27
28 29 30

abc	pts/0	2017-09-06 16:40 (192.24.46.63)
mabdulah	pts/1	2017-09-13 12:53 (192.24.46.212)
xyz	pts/3	2017-09-11 10:39 (192.24.46.32)
jsx	pts/5	2017-08-31 09:00 (192.25.172.215)

Modify the Figure 3 code or Write your own program for a command-line shell that can handle multiple commands per line as illustrated in the above example.

2.   **Handling pipe (|) and more command**   **10 Points**

The simple shell interface provided in Figure 3 does not handle the use of pipe (|) and "more" command, which is available in actual linux shell,

-bash-4.3$ ls -l |more
with the following output:
total 59777
drwx------. 5 mabdulah domain users   476 Feb 18 2016 abc
drwx------. 2 mabdulah domain users   3031 Feb 14 2017 xyz
-rwx------. 1 mabdulah domain users 1867288 Jan 22 2017 abc.docx
-rwx------. 1 mabdulah domain users 1719552 Jan 22 2017 xyz.pdf
--More--

Modify the Figure 3 code or write your own program to allow the use of pipe (|) and "more" command by the command-line shell as illustrated by above example.

Submission

- You should use C to develop the code.
- You need to turn in electronically by submitting a zip file named Firstname_Lastname_Project1.zip.

- Source code must include proper documentation to receive full credit.
- All projects require the use of a make file or a certain script file (accompanying with a readme file to specify how to use the script file to compile), such that the grader will be able to compile/build your executable by simply typing "make" or some simple command that you specify in your readme file.

- Source code must compile and run correctly on the department machine "pyrite", which will be used by the TA for grading.

- You are responsible for thoroughly testing and debugging your code. The TA may try to break your code by subjecting it to bizarre test cases.
- You can have multiple submissions, but the TA will grade only the last one.

Start as early as possible!