Kenny Liu, Jesus Mendoza

Dr. Xiaoyu Zhang

CS433 - Operating Systems

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Assignment 2 Report

Submitted Files:

● prog.cpp

How to Compile/Run the Program:

To compile: make

Execute: ./prog2

Features implemented:

● This project consisted of designing a C program to serve as a shell interface that accepts

user commands and then executes each command in a separate process.

● int main(int args, char \*argv[])

○ char command[] is where the user command is stored, char \*args is for the

command after it is split up into arguments, should\_run is our flag to know

whether to stop the program or not, and our history vector is also initialized here

○ If user enters the command “exit”, should\_run changes to 0 and ends the program

○ If command is “!!”, it will display “No command history” if there is no previous

commands, otherwise, it will display the last command and execute it

○ For regular commands - It will first go through a loop whether a space is needed

before an &, for example, “ls&”. It will then parse the command and execute it.

● Splitting command to arguments - parse\_command(char command[], char \*args[])

○ We first initialize a pointer named \*tok that will go through a command, and point

to arguments, as well as count that counts how many arguments there are in the

command

○ tok = strtok(NULL, “ “) is first executed in which tok is pointing at the argument

before the first space. The arguments tok is pointing at will be placed into the args

array and increments count, unless it includes a ‘<‘, ‘|’, or ‘>’, which is skipped

over and doesn’t increment count. Tok is also updated to point at the next

argument until it is NULL

○ After the command is split into arguments in args[], we check the last index

whether it includes an ampersand or not. If there is an ampersand, we set our bool

ampersand to true, and set that index to NULL

● Executing a command - execArgs(char command[], char \*Args[])

○ Before it gets forked, it gets checked for the pipe (First part)

■ First, set two integer variables to represent two child processes (child1 &

child2) and another integer to represent the pipe file descriptor (fd[2].)

■ Next, set an if statement with the pipe function (pipe(fd)) for exception

handling, which will abort.

■ Setting a switch statement that will read the following test cases from the

fork of child1. If statement wouldn’t work to fork child1 because the result

of an assignment as a condition would not be performed. The following

test cases check if the case is -1 (or child1 <= 0) to abort, and case 0 to

close the first child (or file descriptor 0) to exit. Set to default when all is

satisfied.

■ Similar to the first child, we will have a switch statement for the second

child to check the following test cases to be performed. The following will

be the same except for case 0. First, declare a signed size integer called

nread that will be used to read the pipe, but before reading the pipe, it

must close the second child (fd[1].) Next, nread will be assigned to the

read(fd[0], command, sizeof(\*command) - 1) where it reads the first child,

with the command and the size of the command line. In the read func, it’s

important to include an asterisk inside the sizeof() since it will return the

size of the char\* instead of char[]. Then, there will be two condition

statements where it aborts if nread < 0, and another condition where it will

terminate the command line, and after the else statement, exit. Set to

default and do nothing once all met. After all the cases, close both child

processes (fd[0] & fd[1].) Once both are closed, check if child1 and child2

still have data to put one of the child processors at the wait stage. Proceed

to the next part once completed.

○ After pipe/no pipe found on command, it will get forked to normal (Second

part)

■ In the 1st step, we are forking a child process using fork(). The value is

stored in pid.

■ If pid is a negative value, there was an error with the fork and displays a

“Fork failed” and executes exit(1).

■ In step 2nd step (pid is 0), the child process will invoke execvp(). Execvp

will pass args[0], where the command is stored, as well as args, or the

whole arguments array. Execvp also returns a negative value if it is unable

to run, thus, we are also checking if the value is less than 0 and displays a

“Command not found” if unable to run, and an exit(1).

■ In the 3rd step, parent will invoke wait() unless the command includes an

& at the end. It will check whether our bool ampersand is false. If false, it

will invoke wait().

● In\_redirect - in\_redirect(char\* file)

○ The passed parameter file is used to serve the input that will be opened.

○ As it is significant to use the standard input (<), it will be redirected to a

command from a file such as “osh> sort < in.txt”

○ In the function, integer i will be set with the open function including file and

O\_RDONLY (Open for reading only.)

○ It will duplicate the open function to create a copy of an existing file descriptor,

and will be followed up with a close function from integer i.

● Out\_redirect - out\_redirect(char\* file)

○ Same as the in\_redirect function it will have the same passed parameter to serve

the output that will be opened.

○ As it is used for the standard output (>), the output will redirect the output of a

command to a file.

○ In the function, integer o will be set with the open function including file,

O\_WRONLY (Open for writing only), O\_APPEND (force the file pointer to

point at the end of file only), O\_TRUNC (cause the file to be truncated/shorten if

it exists), O\_CREAT (call to open() with a mode argument), and 0600 (octal 600

or 384 in decimal in order to perform a signed char.)

○ It will follow the same format after assigning integer o and will be followed up

with a close function.

Additional:

● Two global variables were used in this programming assignment, which was ampersand

and MAX\_LINE.

○ The ampersand variable is a bool type that will be used to determine whether the

parent will invoke wait(). It only invokes wait if a user enters an ampersand after

their command

○ The MAX\_LINE variable is defined as the maximum length command, which

will be addressed in any of the character arrays that will be used for viewing the

characters of any command typed.

Choice of Data Structure: We decided to use vectors for this programming assignment because

it is easily utilized to insert new elements inside. As a result, we would assign our history

variable as a string type to be used for tracking the characters that are saved in the shell. It will

use the empty function that will check if the history is empty, the size function to get the last

index element recorded to retrieve the last command recorded, and the push\_back function that

will get the last command recorded and push it into the history.

Lessons Learned/Re-learned:

Kenny Liu:

● At first, it was confusing even with the starter code because I was unfamiliar with C. I

had to do a lot of searches and reading to understand a lot of the C functions we used.

After attending office hours, it became so much clearer on what the program is trying to

do, especially what execvp() does. Being able to talk to classmates also helped, especially

with those who had the same errors on gradescope. Because of this, we were able to get

our ampersand to work, as we were unaware we needed to take into account a test case

where there are no spaces. Me and my partner also started this assignment early and met

up in the library computer lab to dedicate time in this program which was beneficial. I

also thought of having our own separate files as we had different approaches and to avoid

editing each other’s code.

Jesus Mendoza:

● Without any experience with C, it was a bit difficult to translate what is expected for this

programming assignment. After reading the instructions from zybooks and other

supporting websites on canvas, it gave me a better understanding as to what is needed.

Additionally, attending office hours with Kyrstn, would clear any unclear or unsure

questions that were in the way such as “Is the history feature supposed to run a certain

way? How do we check the ps -aef issue on gradescope?” Furthermore, it resulted with

benefits as we would end up getting full credit for the code section, due to time

constraints, we would somewhat be unaware of what the issue may be on the pipe, but

then with further research, the pipe would soon work on the program. As to what Kyrstn

said, we would tend to meet at our available times to work on the assignment as early as

possible and doing so made us balance our time to knock each step of what is noted in

zybooks. While we did work on different files to do this programming assignment, we

would compare and converse about the best way to implement the assignment and debug

the issues one of us may have. In summary, this was a great way to practice pair

programming and a great experience to work alongside with Kyrstn to learn and work as

a team.

Sources:

- Other ways to parse a command in C++/C

- How the strtok function works

- Used to reference for A2

- What the '\0' does of a character string

- What cpu-api does and reference for coding this programming assignment

- Use of fgets() in C

- strcmp function

- How to use ssize\_t from the <sys/types.h> library

- How to implement pipes in C