

Programming Assignment #1 – A Simple Shell

Introduction to Operating Systems

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A Simple Shell

- Control flow of your simple shell:
 - Display the prompt sign “>” and take a string from user
 - Parse the string into a program name and arguments
 - Fork a child process
 - Have the child process execute the program
 - Wait until the child terminates
 - Go to the first step

Example Output

```
justin@justin-virtual-machine:~/Desktop/SimpleShell$ ls
a.out  shell.c  shell.o  simpleshell.c  simpleshell.o  trace
justin@justin-virtual-machine:~/Desktop/SimpleShell$ ./a.out
>ls
a.out  shell.c  shell.o  simpleshell.c  simpleshell.o  trace
>/bin/ls
a.out  shell.c  shell.o  simpleshell.c  simpleshell.o  trace
>which ls
/bin/ls
>rm shell.o
>ls
a.out  shell.c  simpleshell.c  simpleshell.o  trace
>
```

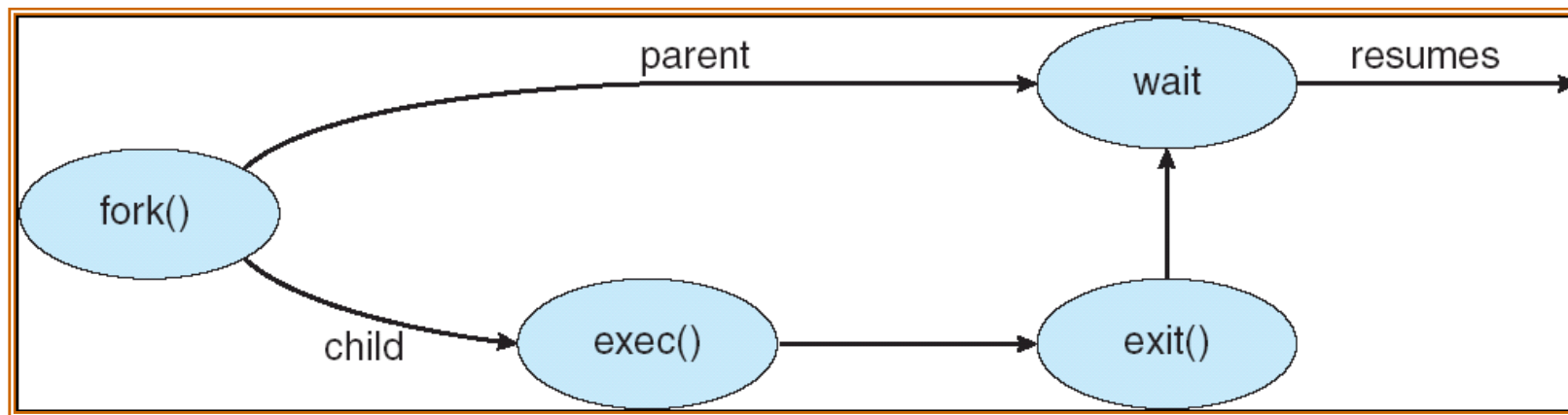
Core Logic of Your Shell

```
pid_t pid;

...

/* fork another process */
pid = fork();
if (pid < 0) { /* error occurred */
    fprintf(stderr, "Fork Failed");
    exit(-1);
}
else if (pid == 0) { /* child process */
    execlp("/bin/ls", "ls", NULL);
}
else { /* parent process */
    /* parent will wait for the child to complete */
    wait (NULL);
}

...
```



Important System Calls

- `fork()`
 - Create a child process
 - <http://man7.org/linux/man-pages/man2/fork.2.html>
- `exec()` family
 - Have the current process execute the program specified in the pathname
 - <http://man7.org/linux/man-pages/man3/exec.3.html>
- `wait()` family
 - `wait()` wait the termination of anyone of the child processes
 - `waitpid()` waits the termination of the specified child process
 - <http://man7.org/linux/man-pages/man2/waitpid.2.html>

Waiting on child processes

- If a command is ended with “&”, then the shell will not wait on a child process
- For example:
 - sleep 10s
 - The prompt re-appears after 10 seconds
 - sleep 10s &
 - The prompt re-appears immediately
- A child process becomes a zombie if it is not waited by its parent process
 - How to deal with this problem?

Header of your .c or .cpp

```
/*
```

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Statement: I am fully aware that this program is not supposed to be posted to a public server, such as a public GitHub repository or a public web page.

```
*/
```


Test Cases

- Your shell must correctly handle test cases of the following format
 - **<program> <arg1> <arg2> <...>**
- Test cases are like the following, but not limited to:
 - **clear**
 - **ls -l**
 - **cp a.txt b.txt**
 - **cat c.txt &**
- Do not leave zombie processes in the system!
 - Before or after your shell terminate
- The header must present in your source program

This. Is. Not. Funny.

- You got zero point if you use `system()`
- You don't have to implement "ls", "cp", etc in our shell; they are independent programs
 - Just create a child process and have the child execute these program

Bonus!

- I/O redirection (+10 pts)
 - `ls -l > a.txt`
- Pipe (+10 pts)
 - `ls | more`
- **No** multiple or combined pipe/redirections
 - `a | b | c`
 - `a < b > c`
 - `a | b > c`
 - ...

Testing OS Environment

- Ubuntu 18.04
- Install as a VM or on a physical machine

Facebook Group

- Ask questions here
- 『 2021nycucsos 』