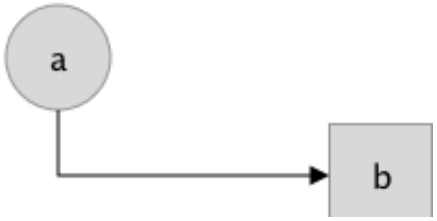
CSC 369 Worksheet 2 Solution

August 17, 2020

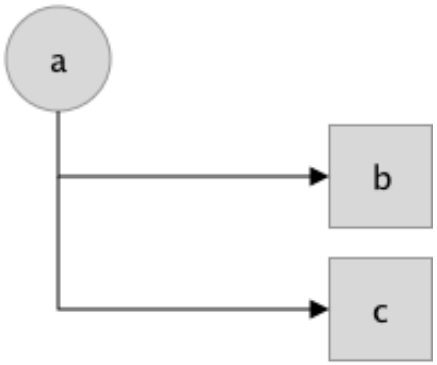
1 Homework (Simulation)

1. I need to create process trees at each step when the command `./fork.py -s 10` is run.

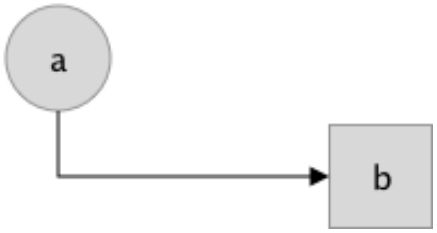
1) Action: a forks b



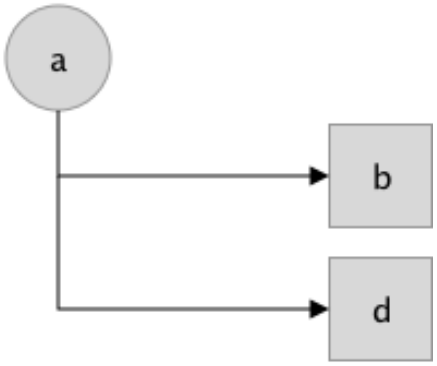
2) Action: a forks c



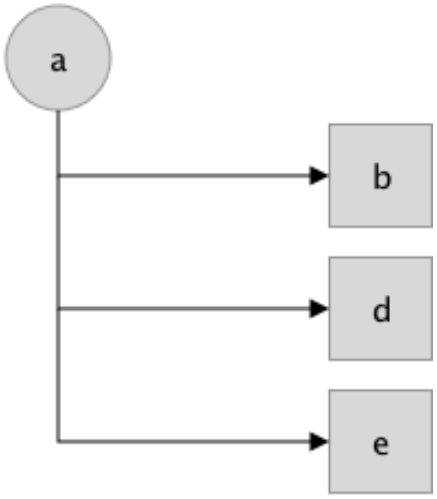
3) Action: c EXITS



4) Action: a forks d



5) Action: a forks e



Notes

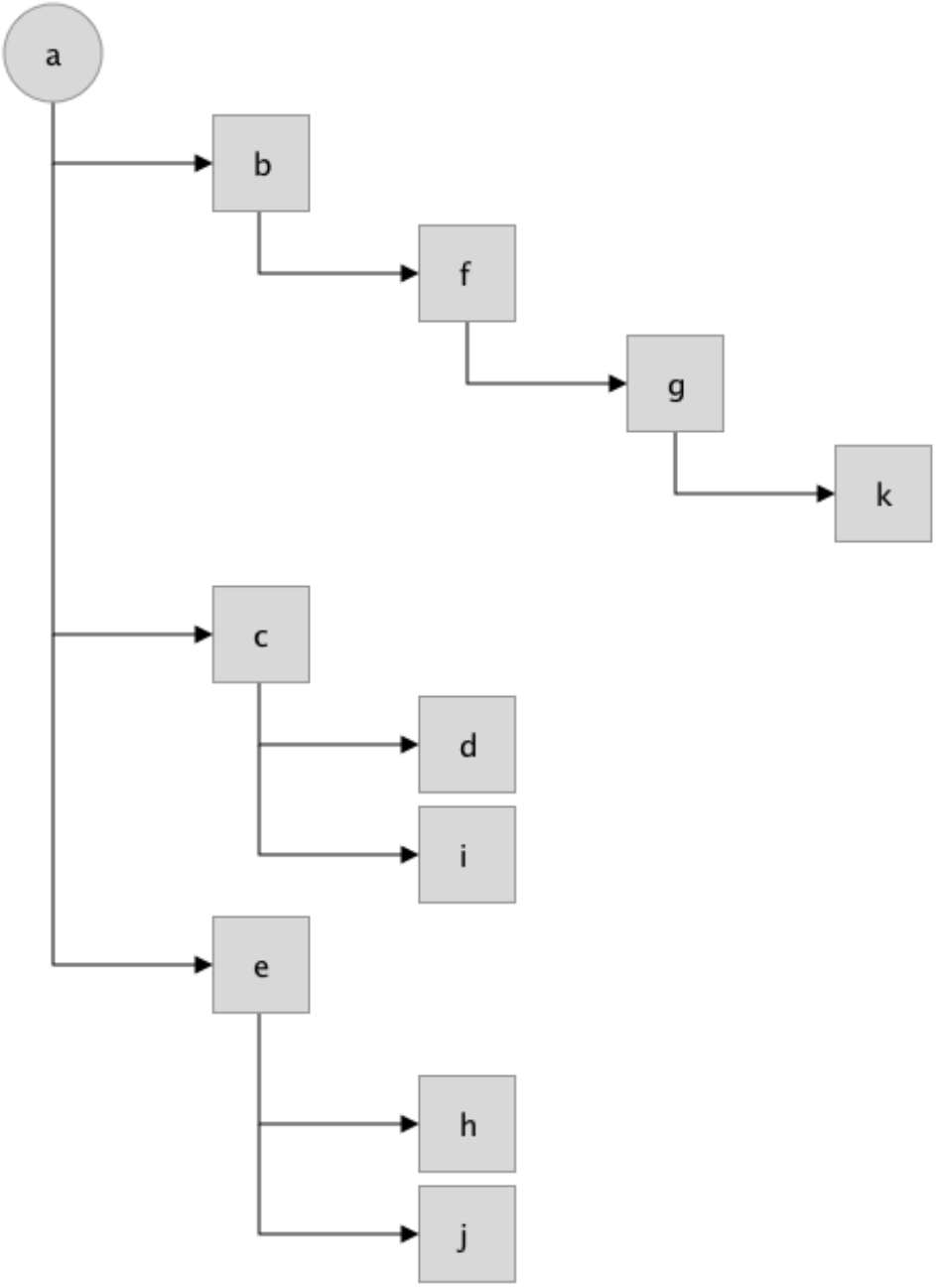
- **fork()**
  - Is used to create a new process
  - **Creator** → parent process
  - **Newly Created** → child process
  - Child process is nearly identical to parent process
- **exec()**
  - Allows a child to break free from its similarity to its parent and execute an entirely new program.
- **wait()**
  - Is used to let parent code delay its execution until the child finishes executing.
  - Makes the output deterministic

2. I need to write what the resulting final process trees will look like as the fork-percentage changes. Here I ran command (`./fork.py -s 10 -a 10 -f 0.1` and `./fork.py -s 10 -a 10 -f 0.9`)

Notes

- `./fork.py -s 10 -a 10 -f 0.1`

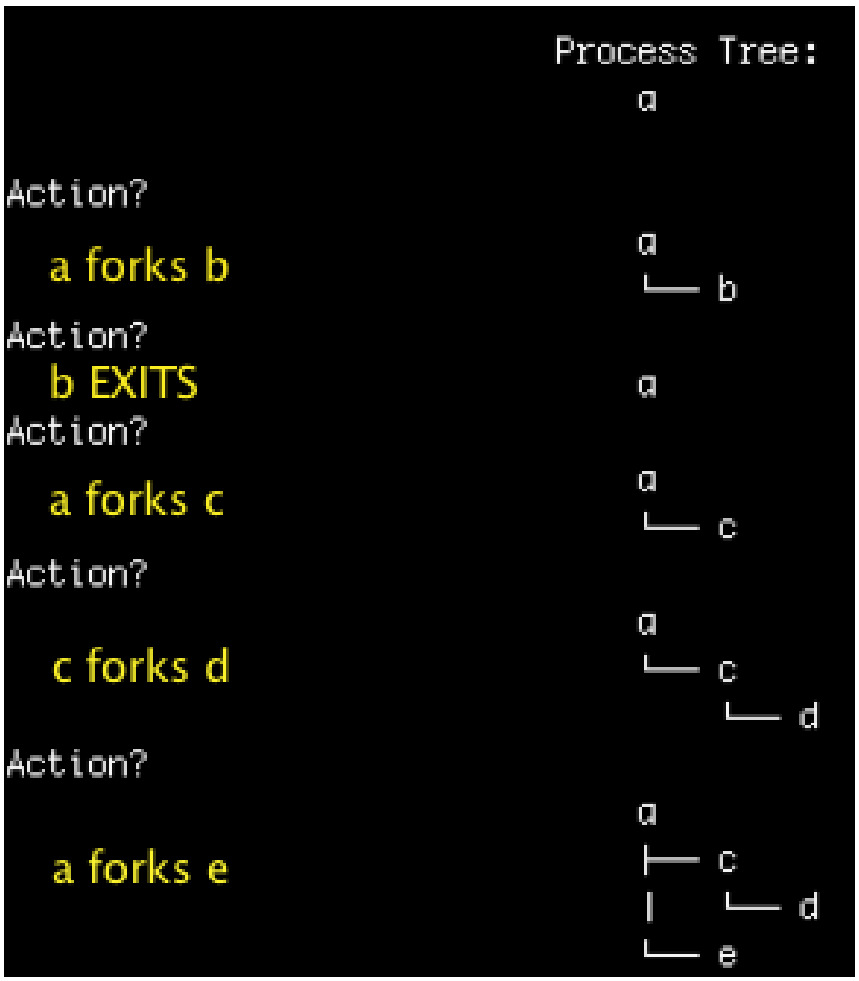
- `./fork.py -s 10 -a 10 -f 0.9`



Based on the diagram above, I can deduce that the lower the fork percentage, the more likely that `exit()` is executed by the childmost process, and the final tree will either have a single node or none.

On the other hand, the higher the fork-percentage is, the more likely that `fork()` is executed by the childmost process, and the final tree will have nodes that are deeply nested.

3. I need to fill out blank entries created by the command (`./fork.py -t`)



4. I need to write what happens when a child exits; what happens to its children in the process tree.

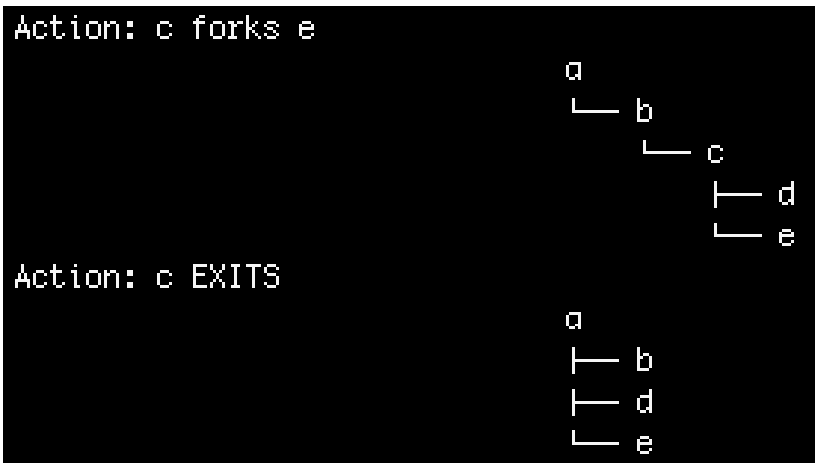
When a child exists, all of its children will also exit.

I am not sure what happens when `-R` flag is used.

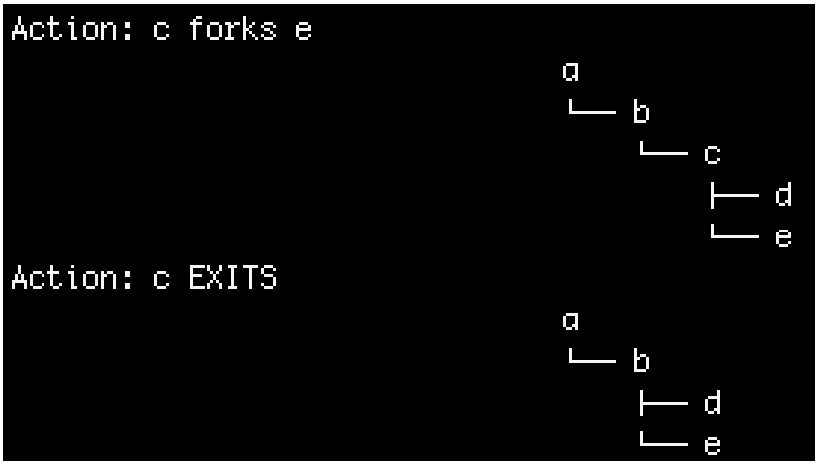
Correct Solution

I need to write what happens when a child exits; what happens to its children in the process tree.

When a child exists, its parentmost child, along with its children, will be attached to the parentmost node



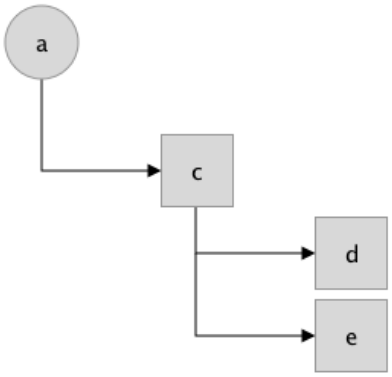
When `-R` flag is used (i.e `./fork.py -A a+b,b+c,c+d,c+e,c- -R`) and a child exists, its parentmost child, along with its children will be attached to the parent node of the child that exits



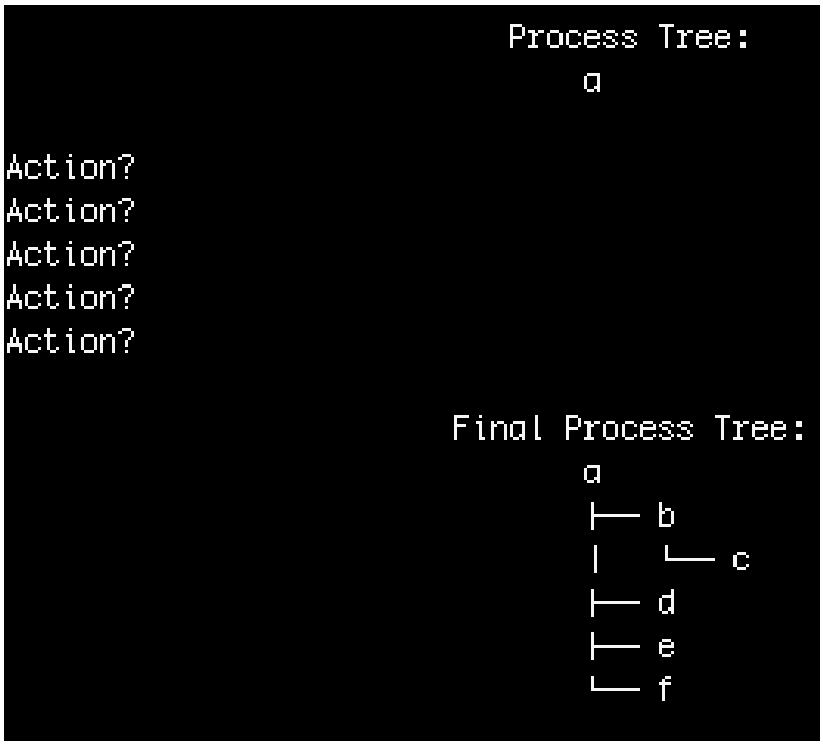
5. I need to write down the final tree by looking at the series of actions generated (here, the command `./fork.py -F` is used).

```
                          Process Tree:
                              a

Action: a forks b
Action: b EXITS
Action: a forks c
Action: c forks d
Action: c forks e

                        Final Process Tree?
```

Answer:



6. First, I need to fill the actions that took place given the final process tree.



Given the final diagram, the missing actions are:

1. Action: a forks b
2. Action: b forks c
3. Action: a forks d
4. Action: a forks e
5. Action: a forks f

Second, I need to write whether I can determine the exact actions that took place, and write where can I tell and cannot tell.

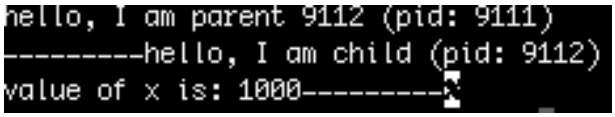
No. I cannot tell exact actions that took place. I can tell what happened upto the latest visible node in the diagram (e.g a, b, c, d, e, f in above diagram), but I cannot tell actions that took place afterwards (e.g. Action: f forks g, Action: a forks h, Action: h EXITS, and Action: g EXITS).

2 Homework (Code)

1. Let $x = 1000$.

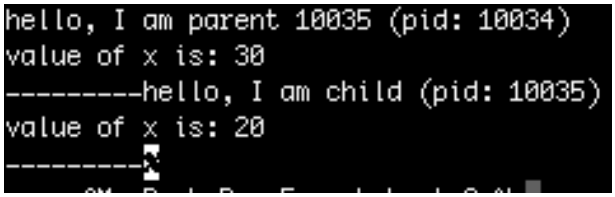
   First, I need to write the value of the variable x in the child process.

   The value of x in child process is the same as the parent (source code is provided in `question_7_part_1.c`).



   Second, I need to write what happens to variable x when both child and the parent change the value of x (source code is provided in `question_7_part_2.c`).

   When the value of x is changed in both child and parent, each possess their own values as if it's their own.

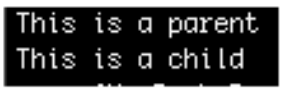


   Notes

   - C file can be compiled via command `gcc -o OUTPUT_FILE_NAME SOURCE_FILE_NAME.c`

2. Yes. Both the child and parent can access the file descriptor returned by `open()`.

   When they are writing to file concurrently, parent's write() is considered before children.



3. Yes. Child can be called first by sufficiently delaying the execution of parent's print function. (Please refer to `question_9.c`).

4. First, I need to write a program that calls `fork()` and then calls some form of `exec()` to run the program `/bin/ls`.

   Please refer to file `question_10.c` for solution.

   Second, I need to write why there are so many variants of the same basic call?

   According to Wikipedia (link), the variations of `exec()` are to satisfy requirements of various programming languages (e.g Python, BASH) and operating systems (e.g Linux, Windows).

   Notes

   - **execl**
     - Doesn't use PATH (a shortcut command). Requires full path of the executable file.

```c
#include <unistd.h>

int main(void) {
    char *binaryPath = "/bin/ls";
    char *arg1 = "-lh";
    char *arg2 = "/home";

    execl(binaryPath, binaryPath, arg1, arg2, NULL);

    return 0;
}
```

   - **execlp**
     - Uses PATH
     - Is structurally similar to `excel()`

```c
#include <unistd.h>

int main(void) {
    char *programName = "ls";
    char *arg1 = "-lh";
    char *arg2 = "/home";

    execlp(programName, programName, arg1, arg2, NULL);

    return 0;
}
```

- **execle**
  - Works like `execl()`
  - Can provide your own environment variables. (e.g. `$PORT`)

```c
#include <unistd.h>

int main(void) {
char *binaryPath = "/bin/bash";
char *arg1 = "-c";
char *arg2 = "echo "Visit $HOSTNAME:$PORT from your browser."";
char *const env[] = {"HOSTNAME=www.linuxhint.com", "PORT=8080",
NULL};

execle(binaryPath, binaryPath,arg1, arg2, NULL, env);

return 0;
}
```

- **execv**
  - **Syntax:** `int execv(const char *path, char *const argv[]);`
  - Passes all arguements in array `argv`

```c
#include <unistd.h>

int main(void) {

    int ret;
    char *cmd[] = { "ls", "-l", NULL};
    ret = execv ("/bin/ls", cmd);
    return 0;
}
```

- **execvp**
  - Works the same as `execvp()`, but the PATH environment variable is used.

```c
#include <unistd.h>

int main(void) {

    int ret;
    char *cmd[] = { "ls", "-l", NULL};
    ret = execv ("ls", cmd);
    return 0;
}
```

- **execve**
  - Works simiarily to `execle()`
  - Can provide own environment variables along with `execv()`.

```c
#include <unistd.h>

int main(void) {
```

```
4
5       int ret;
6       char *cmd[] = { "ls", "-l", NULL};
7       char *const env[] = {"HOME=/usr/moegu", "LOGNAME=moegu",
    NULL};
8       ret = execve ("/bin/ls", cmd, env);
9       return 0;
10    }
```

References

1) Linuxhunt, Exec System Call in C, link

2) SysTutorials, execle (3p) - Linux Man Pages, link