

BD-shell

Introduction

BD-shell (a.k.a. bdsh) is a tiny unix shell written in C. This document describes its functionalities and presents some user interactions with the program which cover all the requirements of the course.

Bdsh has been tested with a very useful program written for the DSA course, with some light modifications. It is a benchmark written in C that measures the insertion of 20000 numbers in two hash tables. At the end of the benchmark, the program asks the user to input a char, then exits. The executable of the program is called “hash_benchmark” and needs about 10 seconds of computations before the user input.

Some Numbers

Lines of Code (LOC): 463

Lines of Comment (COM): 312

How many times a System Call was used: 47

System Calls used: exit, open, close, dup2, execvp, fork, signal, setpgrp, tcsetpgrp, setpgid, kill, waitpid, chdir, getenv, getpid, tcgetpgrp, getpgrp,

Signals Involved: SIGINT, SIGQUIT, SIGTSTP, SIGCHLD, SIGTTIN, SIGCONT, SIGQUIT, SIGTTOU

Signal handlers: 1

First Run

This is what the user sees after the shell execution:

```
Naamah:~ bodom_lx$ ./bdsh
-----
Welcome to BD-shell version 1.0.0
This is bdsh with process id: 981
-----
bodom_lx - /Users/bodom_lx j: 0>
```

A little welcome screen prints out the name of the shell, its version and the pid it is assigned by the Operating System (will be called OS from this point). The last line is the prompt divided in this way:

user name – current working directory j: number of jobs launched not yet terminated>

Functionalities and user interactions

To describe the functionalities of bdsh, I am going to use the official requirements of the course as main points (<http://www.inf.unibz.it/~david/os/project.html>).

Use, combine, and extend the programs you wrote for LAB 1 and LAB 2 to a mini-shell that is able to do the following:

To read commands from standard input and execute them in a loop until a built-in command exit is issued (we call these processes the foreground processes; there is always at most one of these at any particular time);

To execute a command, user has to write its name and hit the return key.

```
bodom_lx - /Users/bodom_lx j: 0> ls
Desktop      Downloads    Movies      Pictures     Sites       bdsh.odt
Documents    Library     Music       Public      bdsh
bodom_lx - /Users/bodom_lx j: 0> exit
Naamah:~ bodom_lx$
```

Be able to redirect the standard input and output of commands by prefixing them with built-in commands in file and out file;

It is possible to either redirect STDIN or STDOUT. The function that does the job is ready to redirect both of them at the same time, but the function that manages the user input does not handle it. EXTRA: it is possible to perform the same operations in background, by prefixing them with “bg”

```
bodom_lx - /Users/bodom_lx j: 0> out files.txt ls
bodom_lx - /Users/bodom_lx j: 0> in files.txt cat
Desktop
Documents
Downloads
Library
Movies
Music
Pictures
Public
Sites
bdsh
bdsh.odt
files.txt
bodom_lx - /Users/bodom_lx j: 0>
```

Be able to terminate (involuntarily) the foreground process when user presses ^C and return back to the mini-shell;

```
bodom_lx - /Users/bodom_lx j: 0> hash_benchmark
-----
Cycle 1 - Numbers interested in this cycle: from 0 to 20000
-----
Successful searches:
  Average Probes for Hash Table with Chaining: 1.138600
  Average Probes for Hash Table with Linear probing: 2.910150
^Cbodom_lx - /Users/bodom_lx j: 0>
```

Be able to interrupt the foreground process temporarily, when user presses ^Z, returning to the mini-shell;

Like the famous bash shell does, when the foreground process is interrupted, the user is informed with the job id and its name:

```
bodom_lx - /Users/bodom_lx j: 0> hash_benchmark
-----
Cycle 1 - Numbers interested in this cycle: from 0 to 20000
-----
Successful searches:
  Average Probes for Hash Table with Chaining: 1.138600
  Average Probes for Hash Table with Linear probing: 2.910150
^Z[1]+  stopped      hash_benchmark
bodom_lx - /Users/bodom_lx j: 1>
```

The number of jobs launched, not yet terminated is increased, too

Be able to execute any number of processes in background (i.e., in parallel with the foreground process), including in particular, the ability to start another process while a process has been temporarily suspended;

To execute a program in background, it is necessary to prefix it with the built-in command `bg`. In the following user interaction, the user executes “hash_benchmark” in background, then executes “ls”, executes “hash_benchmark” in foreground and suspends it, having the first command still in background and another command stopped (j is 2). After the job suspension, another “ls” is executed and the first process launched in background exits normally.

```
bodom_lx - /Users/bodom_lx j: 0> bg hash_benchmark
[1] 2126

-----
Cycle 1 - Numbers interested in this cycle: from 0 to 20000
-----
Successful searches:
    Average Probes for Hash Table with Chaining: 1.138600
    Average Probes for Hash Table with Linear probing: 2.910150

bodom_lx - /Users/bodom_lx j: 1> ls
Desktop      Downloads  Movies      Pictures     Sites        bdsh.odt
Documents    Library    Music        Public       bdsh          files.txt
bodom_lx - /Users/bodom_lx j: 1> hash_benchmark

-----
Cycle 1 - Numbers interested in this cycle: from 0 to 20000
-----
Successful searches:
    Average Probes for Hash Table with Chaining: 1.138600
    Average Probes for Hash Table with Linear probing: 2.910150

^Z[2]+  stopped          hash_benchmark
bodom_lx - /Users/bodom_lx j: 2> ls
Desktop      Downloads  Movies      Pictures     Sites        bdsh.odt
Documents    Library    Music        Public       bdsh          files.txt
bodom_lx - /Users/bodom_lx j: 2> Unsuccessful searches:
    Average Probes for Hash Table with Chaining: 0.928050
    Average Probes for Hash Table with Linear probing: 20000.000000
-----

input a char:
you did not write 'c'
[1]+  Done          hash_benchmark

bodom_lx - /Users/bodom_lx j: 1>
```

Inform the user when the background process finishes or is waiting for an input from the terminal;

The last user interaction covers the first point. If a background process is waiting for an input from the terminal, the process is suspended, marked as “waiting for input” (W) and the user is warned:

```
bodom_lx - /Users/bodom_lx j: 0> bg hash_benchmark
[1] 7135

-----
Cycle 1 - Numbers interested in this cycle: from 0 to 20000
-----
Successful searches:
  Average Probes for Hash Table with Chaining: 1.138600
  Average Probes for Hash Table with Linear probing: 2.910150

bodom_lx - /Users/bodom_lx j: 1>
bodom_lx - /Users/bodom_lx j: 1> Unsuccessful searches:
  Average Probes for Hash Table with Chaining: 0.928050
  Average Probes for Hash Table with Linear probing: 20000.000000
-----

input a char:
[1]+  suspended [wants input]      hash_benchmark

bodom_lx - /Users/bodom_lx j: 1> jobs

Active jobs:
-----
| job no.   name                pid   descriptor   status|
-----
| [1]      hash_benchmark  7135   STANDARD      W      |
-----

bodom_lx - /Users/bodom_lx j: 1>
```

Be able to inform the user what commands are executing in the background by issuing the built-in command jobs, this should include information about the state of the process (i.e., suspended, background, waiting for input, etc.) and about what file(s) is the background process using for standard input and output);

A very nice table is printed out when the jobs command is issued. In this user interaction, two commands had been given, both “hash_benchmark”, the first was suspended by the user, the second was launched in background:

```
bodom_lx - /Users/bodom_lx j: 2> jobs

Active jobs:
-----
| job no.   name                pid   descriptor   status|
-----
| [1]      hash_benchmark  2437   STANDARD      S      |
| [2]      hash_benchmark  2440   STANDARD      B      |
-----
```

The table is self-explanatory.

Be able to terminate involuntarily a background processes by issuing the built-in command `kill job-number`.

The possibility to terminate a stopped process were also implemented:

```
bodom_lx - /Users/bodom_lx j: 2> jobs
Active jobs:
-----
| job no.   name                pid   descriptor  status |
-----
| [1]      hash_benchmark 2870   STANDARD    S      |
| [2]      hash_benchmark 2873   STANDARD    B      |
-----
bodom_lx - /Users/bodom_lx j: 2> kill 1
[1]+  KILLED      hash_benchmark
bodom_lx - /Users/bodom_lx j: 1> jobs
Active jobs:
-----
| job no.   name                pid   descriptor  status |
-----
| [2]      hash_benchmark 2873   STANDARD    B      |
-----
bodom_lx - /Users/bodom_lx j: 1> kill 2
[2]+  KILLED      hash_benchmark
bodom_lx - /Users/bodom_lx j: 0> jobs
Active jobs:
-----
| job no.   name                pid   descriptor  status |
-----
|          No Jobs                                     |
-----
bodom_lx - /Users/bodom_lx j: 0>
```

To be able to resume a process or to make a background process into the foreground process (i.e., the one that currently interacts with the terminal) by issuing the `fg job-number` command.

In this example, the user first makes a background process into the foreground process, then resumes a suspended process. Process waiting for input may also be resumed.

```
bodom_lx - /Users/bodom_lx j: 2> jobs

Active jobs:
-----
|job no.   name                pid   descriptor  status|
-----
| [1]      hash_benchmark  2982   STANDARD    S      |
| [2]      hash_benchmark  2985   STANDARD    B      |
-----

bodom_lx - /Users/bodom_lx j: 2> fg 2
Unsuccessful searches:
    Average Probes for Hash Table with Chaining: 0.928050
    Average Probes for Hash Table with Linear probing: 20000.000000
-----

input a char:
you did not write 'c'
bodom_lx - /Users/bodom_lx j: 1> jobs

Active jobs:
-----
|job no.   name                pid   descriptor  status|
-----
| [1]      hash_benchmark  2982   STANDARD    S      |
-----

bodom_lx - /Users/bodom_lx j: 1> fg 1
Unsuccessful searches:
    Average Probes for Hash Table with Chaining: 0.928050
    Average Probes for Hash Table with Linear probing: 20000.000000
-----

input a char:
you did not write 'c'
bodom_lx - /Users/bodom_lx j: 0> jobs

Active jobs:
-----
|job no.   name                pid   descriptor  status|
-----
|          No Jobs                                     |
-----

bodom_lx - /Users/bodom_lx j: 0>
```