P1 - Local Shell

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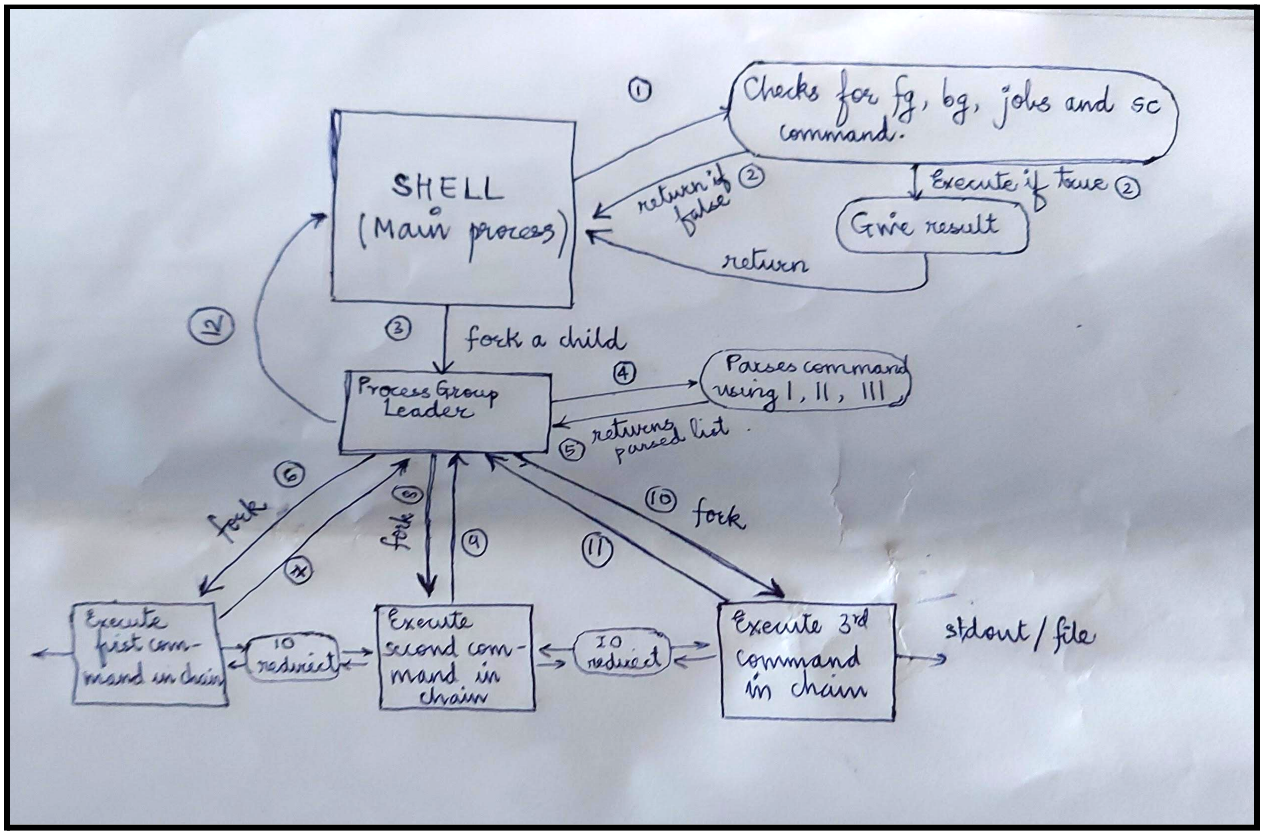
Design Decisions :

We implement a basic bash-like shell with support for job control, process chaining using pipes, input-output redirection, and some custom commands such as double pipes, triple pipes and shortcut mode.

Assumptions :

1. **fg** and **bg** commands are always issued in the format **fg %<num>** and **bg %<num>**, where <num> for jobs can be obtained using **jobs** command.
2. Support for **cd**, **cd ~** and **cd <path>** is included.
3. **||** and **|||** operators are always present at the end of process command chain, if any: **<command>|<command>[[||, |||] <command>,<command>[, <command>,** ϵ **],** ϵ **]**.
   [a, b, c] indicates choosing any one of the options. ϵ indicates empty string.
4. Redirection and piping combinations are allowed.
5. Input redirection and Output redirection in the same command are not allowed:
   e.g. sort < b.txt > a.txt.
6. Use **quit** or **exit** command to close the shell.
7. Use **psc** command to display shortcut commands.



Implementation :
For job control, we use a message queue to indicate when a job exits, becomes background, or comes to foreground. Message queue is used because we need to preserve the current state across all children. Job control table maintains the running or stopped status of each process.

Execution flow :

1. The main shell process shows the prompt to the user.
2. On receiving the command input, the main process checks for **fg, bg, jobs** and **sc** command.
    a. If it is one of these commands, then the main process handles them. After completion of any one of these commands, it shows the user a prompt waiting for a new command.
    b. If not, then for every new command(alternatively, process chain), main process creates a child, puts it in the new process group, gives the control of the terminal to the process chain if it is a foreground job, prints child details, adds process chain to the job control table if it is a background job, and waits for the command to complete if it is a foreground command. For a background command, the main process doesn't wait and simply shows the user a prompt waiting for new input.
3. The child process parses the input command (process chain) from shell, separates the command using |, ||, and |||, thus generating new individual commands. It also adjusts IO redirection for each individual command in the chain. The child then handles each individual command by forking a child(grand child of the main shell process), waits for this forked child to be over and then proceeds to the next individual command in the chain. The forked child(grand child of the main shell process) checks for path, arguments, and then uses execv() to run the command. This completes the wait of the child process(child of main shell) and then it proceeds to the next command in chain.

Usage :
Change to the directory in which the source code is present, then
Compile :
In the bash terminal, issue command: **make** or **make shell**
Run :
In the bash terminal, issue command: **./shell**

```
>> ls -l || grep h, grep j
Command : ls -l || grep h, grep j
Command Details:
        PID  : 14934
        PGID : 14934
        Status : RUNNING
        Type : FOREGROUND
```

```
--------------------------------------------------
Executing current command : ls -l
        PID: 14935
        PGID: 14934

        Read fd  : 0
        Write fd : 4
--------------------------------------------------
--------------------------------------------------
--------------------------------------------------
Executing current command : grep h
        PID: 14937
        PGID: 14934

        Read fd  : 4
        Write fd : 1
--------------------------------------------------
-rw-rw-r-- 1 abdulkk49 abdulkk49  1112 Mar 24 14:09 basic.h
-rw-rw-r-- 1 abdulkk49 abdulkk49   657 Mar 23 03:05 exec_command.h
-rw-rw-r-- 1 abdulkk49 abdulkk49   487 Mar 27 20:26 job_control.h
-rw-rw-r-- 1 abdulkk49 abdulkk49   615 Mar 20 00:35 job_table.h
-rw-rw-r-- 1 abdulkk49 abdulkk49   573 Mar 27 20:26 parse_command.h
-rw-rw-r-- 1 abdulkk49 abdulkk49   288 Mar 27 20:26 sc_table.h
-rwxrwxr-x 1 abdulkk49 abdulkk49 41240 Mar 28 20:17 shell
-rw-rw-r-- 1 abdulkk49 abdulkk49  9874 Mar 27 23:37 shell.c
-rw-rw-r-- 1 abdulkk49 abdulkk49   574 Mar 23 19:27 shell.h
-rw-rw-r-- 1 abdulkk49 abdulkk49 12248 Mar 28 20:17 shell.o
--------------------------------------------------
Executing current command :  grep j
        PID: 14938
        PGID: 14934

        Read fd  : 4
        Write fd : 1
--------------------------------------------------
-rw-rw-r-- 1 abdulkk49 abdulkk49  4360 Mar 23 04:21 job_control.c
-rw-rw-r-- 1 abdulkk49 abdulkk49   487 Mar 27 20:26 job_control.h
-rw-rw-r-- 1 abdulkk49 abdulkk49  7440 Mar 28 20:17 job_control.o
-rw-rw-r-- 1 abdulkk49 abdulkk49  1397 Mar 23 04:21 job_table.c
-rw-rw-r-- 1 abdulkk49 abdulkk49   615 Mar 20 00:35 job_table.h
-rw-rw-r-- 1 abdulkk49 abdulkk49  3600 Mar 28 20:17 job_table.o

>>
```

```
>> sort < a.txt
Command : sort < a.txt
Command Details:
        PID  : 15564
        PGID : 15564
        Status : RUNNING
        Type : FOREGROUND

--------------------------------------------------
Executing current command : sort < a.txt
        PID: 15565
        PGID: 15564

        Read fd  : 0
        Write fd : 1
--------------------------------------------------
File name : a.txt
        Original fd : 0
        Remapped fd : 3
-rw-rw-r-- 1 abdulkk49 abdulkk49  1112 Mar 24 14:09 basic.h
-rw-rw-r-- 1 abdulkk49 abdulkk49 12248 Mar 28 20:17 shell.o
-rw-rw-r-- 1 abdulkk49 abdulkk49  1709 Mar 27 20:27 sc_table.c
-rw-rw-r-- 1 abdulkk49 abdulkk49  2793 Mar 23 16:04 parse_command.c
-rw-rw-r-- 1 abdulkk49 abdulkk49   288 Mar 27 20:26 sc_table.h
-rw-rw-r-- 1 abdulkk49 abdulkk49  3656 Mar 28 20:17 parse_command.o
-rw-rw-r-- 1 abdulkk49 abdulkk49  4432 Mar 28 20:17 sc_table.o
-rw-rw-r-- 1 abdulkk49 abdulkk49   573 Mar 27 20:26 parse_command.h
-rw-rw-r-- 1 abdulkk49 abdulkk49   574 Mar 23 19:27 shell.h
-rw-rw-r-- 1 abdulkk49 abdulkk49  9874 Mar 27 23:37 shell.c
-rwxrwxr-x 1 abdulkk49 abdulkk49 41240 Mar 28 20:17 shell

>>
```

```
>> ls -l | grep -a s > a.txt
Command : ls -l | grep -a s > a.txt
Command Details:
        PID  : 14780
        PGID : 14780
        Status : RUNNING
        Type : FOREGROUND

-------------------------------------------------
Executing current command : ls -l
        PID: 14781
        PGID: 14780

        Read fd  : 0
        Write fd : 4
-------------------------------------------------
-------------------------------------------------
Executing current command : grep -a s > a.txt
        PID: 14782
        PGID: 14780

        Read fd  : 3
        Write fd : 1
-------------------------------------------------
File name : a.txt
        Original Write fd : 1
        Remapped Write fd : 3

>>
```

```
>> sleep 20 &
Command : sleep 20
Command Details:
        PID  : 15487
        PGID : 15487
        Status : RUNNING
        Type : BACKGROUND


>> -------------------------------------------------
Executing current command : sleep 20
        PID: 15488
        PGID: 15487

        Read fd  : 0
        Write fd : 1
-------------------------------------------------


>> fg %0
Command : fg %0
Job no : 0

[0]      Job Terminated  sleep 20

>>
```

```
************** SHELL EXECUTION STARTED **************

Shell Details:
        PID  : 17320
        PGID : 17320


>> sc -i 1 ls -l | wc
Command : sc -i 1 ls -l | wc
ls -l | wc

>> sc -i 2 ls
Command : sc -i 2 ls
ls

>> ^C
----ENTERED SHORTCUT MODE----

>1
-----------------------------------------------------
Executing current command : ls -l
        PID: 17322
        PGID: 17321

        Read fd  : 0
        Write fd : 4
-----------------------------------------------------
-----------------------------------------------------
Executing current command : wc
        PID: 17323
        PGID: 17321

        Read fd  : 3
        Write fd : 1
-----------------------------------------------------
     24     209    1470


>>
```