Q1. Shell

Run

```
make run
```

Features

- For each command, the shell creates a new process group and gives foreground control to that group. Upon completion of the command, the foreground control is given back to the main process.
- Shell also supports background commands. In that case, the command is not given foreground control and continues running in the background.
- Shell supports input and output redirection operations
- Shell supports pipelining (|, ||, and |||)
- Shell supports adding, deleting and running a short-cut command. While insertion, if a short-cut command with the index already exists, the shell confirms whether to replace it. The index can be any integer.

Assumptions

For simplicity, several assumptions were made -

- The maximum number of arguments in a command allowed is 20
- The size of each argument should not exceed 30
- Each identifier in a command should be separated by a space. eg: `ls | cat >> out.txt` is valid but `ls | cat>>out.txt` is not valid.
- It is assumed that the index of each shortcut command would be unique. Hence, while deleting a short-cut command, only the index is required. eg: both `sc -d 1` and `sc -d 1 ls | cat` are valid commands.

# Design

Commands separated by single pipe |

Sample command: `ls -l | wc | cat >> out.txt`
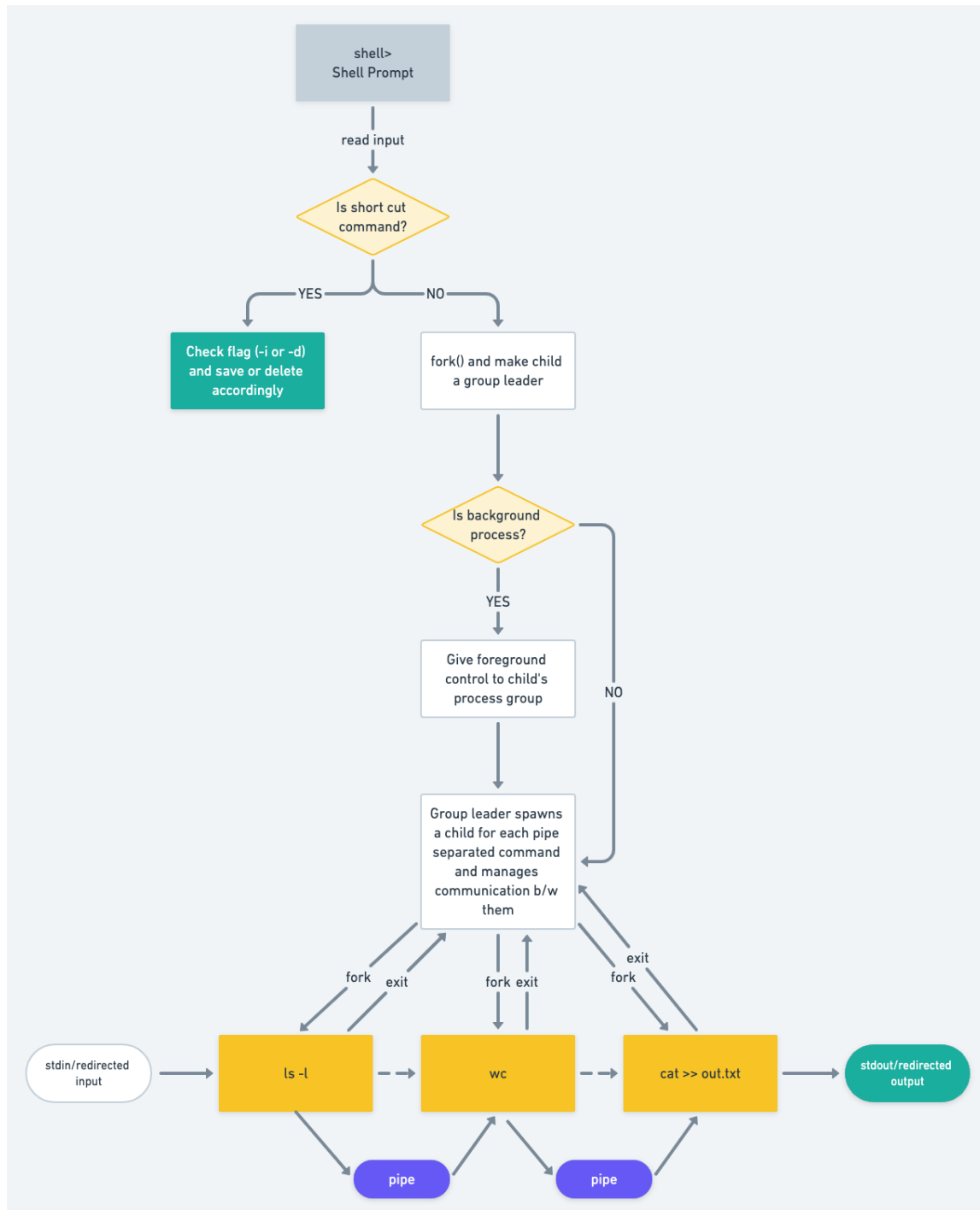
Commands separated by double or triple pipes (|| or |||)

Sample command: `ls -l || wc, cat >> out.txt`

In this case, both the `wc` and `cat >> out.txt` commands should get an input as the output of `ls -l` command. Since reads in pipe are destructive, when `wc` command is run, we first buffer the data in the pipe (output of `ls`) into a char array. Then, we write that data back to two pipes, one for `wc` and one for `cat >> out.txt`. The figure below depicts the implementation.
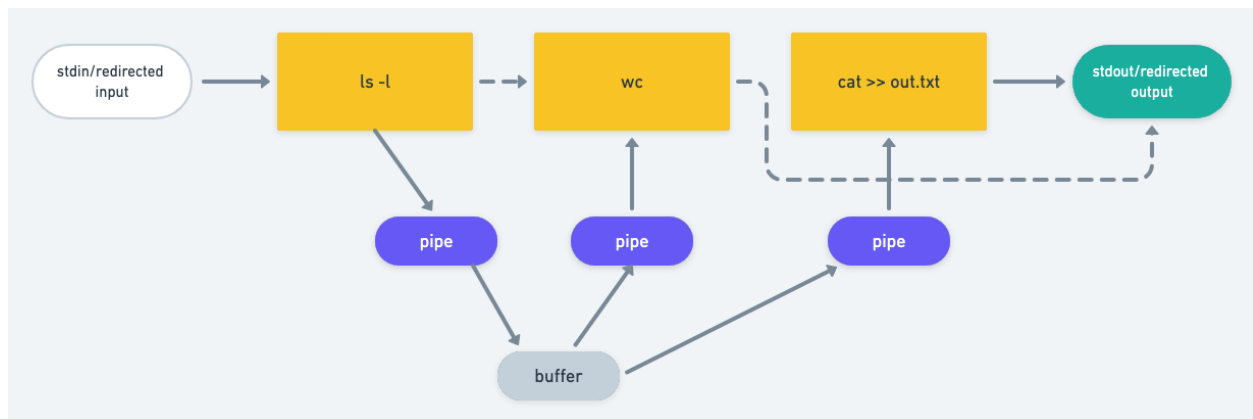
Example Commands

- Simple shell commands

```
shell> ls

shell> pwd
```

- Piped commands

```
shell> ls -l | wc

shell> ls -l ||  grep ^-, grep ^d

shell> ls -l ||| grep ^-, grep ^d, cat >> out.txt
```

- Background commands

```
shell> ls -l | wc&
```

- Short-cut commands

```
shell> sc -i 1 ls -l | wc

shell> Ctrl+C
Enter command index: 1

shell> sc -d 1 ls -l | wc
```

- Quitting the shell

```
shell> exit
```

Screenshots

Simple shell commands

```
gcc -o shell.out shell.c hash_map.c utils.c driver.c
./shell.out

shell> ls

=========== pid: 17808 ===========

===== pid: 17812, executing: ls, read pipe fd: 0, write pipe fd: 1 =====
Makefile         driver.c        hash_map.h       q1_design_2.png  shell.h          utils.c
design.md        hash_map.c      q1_design_1.png  shell.c          shell.out        utils.h

shell> pwd

=========== pid: 17808 ===========

===== pid: 17818, executing: pwd, read pipe fd: 0, write pipe fd: 1 =====
/Users/sarthaksehgal/Personal/4-2/NetProg/netprog-assignment-1/q1
```

Piped Commands

```
shell> ls -l | wc

=========== pid: 17808 ===========

===== pid: 17843, executing: ls, read pipe fd: 0, write pipe fd: 4 =====

===== pid: 17844, executing: wc, read pipe fd: 3, write pipe fd: 1 =====
     13     110     806

shell> ls -l ||  grep ^-, grep ^d

=========== pid: 17808 ===========

===== pid: 17873, executing: ls, read pipe fd: 0, write pipe fd: 4 =====

===== pid: 17874, executing: grep, read pipe fd: 3, write pipe fd: 1 =====
-rw-r--r--  1 sarthaksehgal  staff      71 Mar 29 19:36 Makefile
-rw-r--r--@ 1 sarthaksehgal  staff    2516 Mar 29 20:03 design.md
-rw-r--r--  1 sarthaksehgal  staff    1611 Mar 18 19:51 driver.c
-rw-r--r--  1 sarthaksehgal  staff    4980 Mar 16 19:06 hash_map.c
-rw-r--r--  1 sarthaksehgal  staff    1370 Mar 17 15:20 hash_map.h
-rw-r--r--@ 1 sarthaksehgal  staff  151430 Mar 18 20:40 q1_design_1.png
-rw-r--r--@ 1 sarthaksehgal  staff   46674 Mar 18 20:40 q1_design_2.png
-rw-r--r--  1 sarthaksehgal  staff   20292 Mar 29 19:59 shell.c
-rw-r--r--  1 sarthaksehgal  staff    2450 Mar 18 18:38 shell.h
-rwxr-xr-x  1 sarthaksehgal  staff   52728 Mar 29 20:03 shell.out
-rw-r--r--  1 sarthaksehgal  staff     520 Mar 20 14:56 utils.c
-rw-r--r--  1 sarthaksehgal  staff     283 Mar 18 18:01 utils.h

===== pid: 17875, executing: grep, read pipe fd: 5, write pipe fd: 1 =====

shell> ls -l ||| grep ^-, grep ^d, cat >> out.txt

=========== pid: 17808 ===========

===== pid: 17921, executing: ls, read pipe fd: 0, write pipe fd: 4 =====

===== pid: 17922, executing: grep, read pipe fd: 3, write pipe fd: 1 =====
-rw-r--r--  1 sarthaksehgal  staff      71 Mar 29 19:36 Makefile
-rw-r--r--@ 1 sarthaksehgal  staff    2516 Mar 29 20:03 design.md
-rw-r--r--  1 sarthaksehgal  staff    1611 Mar 18 19:51 driver.c
-rw-r--r--  1 sarthaksehgal  staff    4980 Mar 16 19:06 hash_map.c
-rw-r--r--  1 sarthaksehgal  staff    1370 Mar 17 15:20 hash_map.h
-rw-r--r--@ 1 sarthaksehgal  staff  151430 Mar 18 20:40 q1_design_1.png
-rw-r--r--@ 1 sarthaksehgal  staff   46674 Mar 18 20:40 q1_design_2.png
-rw-r--r--  1 sarthaksehgal  staff   20292 Mar 29 19:59 shell.c
-rw-r--r--  1 sarthaksehgal  staff    2450 Mar 18 18:38 shell.h
-rwxr-xr-x  1 sarthaksehgal  staff   52728 Mar 29 20:03 shell.out
-rw-r--r--  1 sarthaksehgal  staff     520 Mar 20 14:56 utils.c
-rw-r--r--  1 sarthaksehgal  staff     283 Mar 18 18:01 utils.h

===== pid: 17923, executing: grep, read pipe fd: 5, write pipe fd: 1 =====

===== pid: 17924, executing: cat, read pipe fd: 7, write pipe fd: 1 =====

<<<<< Output Redirection found! Initial o/p FD: 1, File FD: 3 >>>>>
```

Background Commands

```
shell> ls -l | wc&

=========== pid: 17808 ===========

shell>
===== pid: 18137, executing: ls, read pipe fd: 0, write pipe fd: 4 =====

===== pid: 18138, executing: wc, read pipe fd: 3, write pipe fd: 1 =====
     14     119     870
ls&

=========== pid: 17808 ===========

shell>
===== pid: 18183, executing: ls, read pipe fd: 0, write pipe fd: 1 =====
Makefile        driver.c        hash_map.h      q1_design_1.png shell.c        shell.out       utils.h
design.md       hash_map.c      out.txt         q1_design_2.png shell.h        utils.c
```

Short-Cut Commands

```
gcc -o shell.out shell.c hash_map.c utils.c driver.c
./shell.out

shell> sc -i 1 ls | wc
Stored shortcut command.

shell> sc -i 42 ls || wc, cat > out.txt
Stored shortcut command.

shell> ^C
Enter command index: 1

=========== pid: 18908 ===========

===== pid: 18993, executing: ls, read pipe fd: 0, write pipe fd: 4 =====

===== pid: 18994, executing: wc, read pipe fd: 3, write pipe fd: 1 =====
      13      13      132

shell> ^C
Enter command index: 2
Short cut command with index 2 not found.

shell> ^C
Enter command index: 42

=========== pid: 18908 ===========

===== pid: 19013, executing: ls, read pipe fd: 0, write pipe fd: 4 =====

===== pid: 19014, executing: wc, read pipe fd: 3, write pipe fd: 1 =====
      13      13      132

===== pid: 19015, executing: cat, read pipe fd: 5, write pipe fd: 1 =====

<<<<< Output Redirection found! Initial o/p FD: 1, File FD: 3 >>>>>

shell> sc -d 1
Deleted shortcut command.

shell> ^C
Enter command index: 1
Short cut command with index 1 not found.

shell> sc -i 42 ls

Command with index 42 already exists, replace (yes/no)? yes
Stored shortcut command.

shell> ^C
Enter command index: 42

=========== pid: 18908 ===========

===== pid: 19081, executing: ls, read pipe fd: 0, write pipe fd: 1 =====
Makefile        driver.c        hash_map.h      q1_design_1.png shell.c         shell.out       utils.h
design.md       hash_map.c      out.txt         q1_design_2.png shell.h         utils.c
```