

Shell

Run

```
gcc -o shell shell.c  
./shell
```

Features implemented

- Simple shell commands

```
ls  
pwd  
clear
```

- Pipelining of commands (Works with files of very large sizes as well, even for those files which exceed pipe buffer limit)

```
ls -l | grep r | wc  
ls -l || head, tail | wc  
cat shell.c ||| wc -c, wc -l, sort > out
```

- Input output redirection

```
ls -l > out  
wc < out  
ls -a >> out
```

- History command

```
history
```

- Command aliasing

```
alias L = ls -l

L

unalias L

alias C = cat shell.c | head || sort, tail -n 5 ||| wc -c, wc -l, wc -w

C

unalias C
```

- Changing directory

```
cd Desktop

cd ..
```

- Exiting shell

```
exit
```

Assumptions

For simplicity, following assumptions have been made

- Maximum number of aliases allowed at a time is 517
- Maximum command size is 1024 characters
- Maximum length of alias variable is 128 characters
- For using alias command, each identifier in the command must be separated by a single space. Thus `alias L = ls -a` is valid but `alias L= ls -a` is not valid
- For using grep command, the pattern must not be enclosed within "". Thus `ls -l | grep r` is valid but `ls -l | grep "r"` isn't valid
- In commands separated by `||` and `|||`, only the last command is allowed to have `|`, `||` or `|||`. The result of the previous commands (previous 2 commands in case of `|||` and previous command in case of `||`) is shown on STDOUT

Design Features

Parsing of input and making the pipeline

- The input is parsed based on the delimiters `, , | , ||` and `|||`

- Each of the tokens obtained in previous step is structured into a command. The information like number of arguments, argument list, input/output redirection or not, whether it is first command after a `||`, etc is extracted from the input and structured into a command
- The above commands are then inserted into a linked list (pipeline)

Execution of commands

- Firstly, it is checked whether the command is a builtin command or any other custom command (alias, unalias or history command, made as a part of extra features). If it is so, it is executed separately
- Pipes are created between successive commands
- A child process is created for each command in the pipeline. In the child, the current command reads its input from the pipe connecting it and the previous command (It reads from STDIN if it's the first command in the pipeline). It writes its output to the pipe connecting it and the next command (It writes to STDOUT if it's the last command in the pipeline)
- For commands which are immediately after a `||` or a `|||`, the input from the pipe is first read into a temporary buffer. A temporary pipe is created and data from the temporary buffer is written into it inside a child process (this child process is created for this purpose only). The data from temporary buffer is also written to the next pipe (also done inside a separate child process). Separate child processes have been created to do the above because otherwise, the whole pipeline may get blocked if the pipe buffer gets full
- If the current command is an input/output redirection operation, the output of the current command is redirected to the file specified in the command
- The command is executed using the `execvp` library call

Additional Features

History command

- A separate linked list is maintained which stores the input entered by the user
- When the user types `history`, the linked list is traversed and the commands inputted by the user before are printed on the terminal with latest command at top

Command Aliasing

- A hash table has been implemented to store the alias name and the command associated with it
- When something like `alias L = ls -a` is executed, the hash table stores the alias name (`L`) and the command associated with it (`ls -a`)
- Whenever the alias (`L` in above example) is entered, the hash table is searched and the command corresponding to the alias (`ls -a` in above example) is executed
- Using the `unalias L` command, the entry corresponding to `L` in hash table is removed

Screenshots

Simple shell commands

```
harsh@harsh: ~/Desktop/npsHELL
harsh@harsh:~/Desktop/npsHELL$ gcc -o shell shell.c
harsh@harsh:~/Desktop/npsHELL$ ./shell
/home/harsh/Desktop/npsHELL:=> ls
221_NP_assignment-1.pdf  shell  shell.c
----- PID: 3543 status: 0 -----
/home/harsh/Desktop/npsHELL:=> pwd
/home/harsh/Desktop/npsHELL
----- PID: 3544 status: 0 -----
/home/harsh/Desktop/npsHELL:=> 
```

Piped commands

```
/home/harsh/Desktop/npsHELL:=> ls -l | grep r | wc
----- PID: 3693 status: 0 -----
      3      27      173
----- PID: 3694 status: 0 -----
----- PID: 3695 status: 0 -----
/home/harsh/Desktop/npsHELL:=> ls -l || head -n 2, tail -n 1 | wc
total 544
-rw-rw-r-- 1 harsh harsh 500313 Oct 16 13:08 221_NP_assignment-1.pdf
----- PID: 3703 status: 0 -----
----- PID: 3702 status: 0 -----
      1       9       53
----- PID: 3706 status: 0 -----
----- PID: 3707 status: 0 -----
/home/harsh/Desktop/npsHELL:=> cat shell.c ||| wc -l, wc -w, sort | tail > out
847
----- PID: 3736 status: 0 -----
1965
----- PID: 3739 status: 0 -----
----- PID: 3735 status: 0 -----
----- PID: 3742 status: 0 -----
----- PID: 3743 status: 0 -----
/home/harsh/Desktop/npsHELL:=> cat out
while (1)
    while ((bytes_read = read(pipe_fd[i - 1][0], &buffer, BUFFER_SIZE)) != 0)
    while (hash_table[hash_value].present == true && probe_no < HASH_TABLE_SIZE)
    while (hash_table[hash_value].present == true && strcmp(alias, hash_table[hash_value].alias) != 0 && probe_no < HASH_TABLE_SIZE)
        while (hn != NULL)
            while (**input != '\0' && **input == '|')
            while (**input != '\0' && isspace(**input))
            while (**input != '|' && **input != ',' && **input != '\0')
            while ((pid = wait(&status)) > 0)
            while (token != NULL)
----- PID: 3746 status: 0 -----
/home/harsh/Desktop/npsHELL:=> 
```

Input and output redirection

```
harsh@harsh: ~/Desktop/npsHELL
----- PID: 3801 status: 0 -----
/home/harsh/Desktop/npsHELL:=> ls -l > out
----- PID: 3807 status: 0 -----
/home/harsh/Desktop/npsHELL:=> cat out
total 544
-rw-rw-r-- 1 harsh harsh 500313 Oct 16 13:08 221_NP_assignment-1.pdf
-rwxrwxr-x 1 harsh harsh 0 Oct 27 22:05 out
-rwxrwxr-x 1 harsh harsh 27144 Oct 27 21:46 shell
-rw-rw-r-- 1 harsh harsh 20658 Oct 18 13:03 shell.c
----- PID: 3808 status: 0 -----
/home/harsh/Desktop/npsHELL:=> wc < out
5 38 232
----- PID: 3809 status: 0 -----
/home/harsh/Desktop/npsHELL:=> ls -a >> out
----- PID: 3824 status: 0 -----
/home/harsh/Desktop/npsHELL:=> cat out
total 544
-rw-rw-r-- 1 harsh harsh 500313 Oct 16 13:08 221_NP_assignment-1.pdf
-rwxrwxr-x 1 harsh harsh 0 Oct 27 22:05 out
-rwxrwxr-x 1 harsh harsh 27144 Oct 27 21:46 shell
-rw-rw-r-- 1 harsh harsh 20658 Oct 18 13:03 shell.c
.
..
221_NP_assignment-1.pdf
.git
.gitignore
out
shell
shell.c
----- PID: 3825 status: 0 -----
/home/harsh/Desktop/npsHELL:=> 
```

History command

```
harsh@harsh: ~/Desktop/npsHELL
----- PID: 3879 status: 0 -----
/home/harsh/Desktop/npsHELL:=> history
clear
cat out
ls -a >> out
wc < out
cat out
ls -l > out
clear
cat out
cat shell.c || wc -l, wc -w, sort | tail > out
ls -l || head -n 2, tail -n 1 | wc
ls -l | grep r | wc
clear
ls -l | grep | wc
clear
ls -l || head, tail | wc
ls -l | grep r | wc
clear
ls -l | grep r
ls -l | grep "r"
pwd
ls
/home/harsh/Desktop/npsHELL:=> 
```

Command aliasing

```
harsh@harsh: ~/Desktop/npsHELL
----- PID: 3922 status: 0 -----
/home/harsh/Desktop/npsHELL:=> alias L = ls -l
/home/harsh/Desktop/npsHELL:=> L
total 548
-rw-rw-r-- 1 harsh harsh 500313 Oct 16 13:08 221_NP_assignment-1.pdf
-rwxrwxr-x 1 harsh harsh 295 Oct 27 22:07 out
-rwxrwxr-x 1 harsh harsh 27144 Oct 27 21:46 shell
-rw-rw-r-- 1 harsh harsh 20658 Oct 18 13:03 shell.c
----- PID: 3923 status: 0 -----
/home/harsh/Desktop/npsHELL:=> unalias L
/home/harsh/Desktop/npsHELL:=> L
execvp: No such file or directory
----- PID: 3929 status: 256 -----
/home/harsh/Desktop/npsHELL:=> alias C = cat shell.c | sort | tail -n 10 | head -n 5
/home/harsh/Desktop/npsHELL:=> C
----- PID: 3932 status: 0 -----
----- PID: 3933 status: 0 -----
----- PID: 3934 status: 0 -----
while (1)
    while ((bytes_read = read(pipe_fd[i - 1][0], &buffer, BUFFER_SIZE)) != 0)
        while (hash_table[hash_value].present == true && probe_no < HASH_TABLE_SIZE)
            while (hash_table[hash_value].present == true && strcmp(alias, hash_table[hash_value].alias) != 0 && probe_no < HASH_TABLE_SIZE)
                while (hn != NULL)
----- PID: 3935 status: 0 -----
/home/harsh/Desktop/npsHELL:=> unalias C
/home/harsh/Desktop/npsHELL:=> C
execvp: No such file or directory
----- PID: 3939 status: 256 -----
/home/harsh/Desktop/npsHELL:=> 
```

Changing directory and quitting shell

```
harsh@harsh: ~/Desktop/npsHELL
----- PID: 3994 status: 0 -----
/home/harsh/Desktop/npsHELL:=> pwd
/home/harsh/Desktop/npsHELL
----- PID: 3995 status: 0 -----
/home/harsh/Desktop/npsHELL:=> cd ..
/home/harsh/Desktop:=> pwd
/home/harsh/Desktop
----- PID: 3996 status: 0 -----
/home/harsh/Desktop:=> cd npsHELL
/home/harsh/Desktop/npsHELL:=> pwd
/home/harsh/Desktop/npsHELL
----- PID: 3997 status: 0 -----
/home/harsh/Desktop/npsHELL:=> exit
harsh@harsh:~/Desktop/npsHELL$ 
```