Birla Institute of Technology & Science - Pilani, K. K. BIRLA Goa campus
Computer Programming (CS F111)
Second Semester 2013-2014
Lab-02
(UNIX Commands)

Contents:

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1. Introduction

Lab 01 sheet described in detail about the creation and editing of files using VI editor and other basic VI commands for working with files. The UNIX command, ***'cat'*** can also be used for creating files. This lab sheet discusses various options of *'cat'* command. The lab sheet also discusses UNIX commands for copying, moving and removing files. In a multi-user system where different people would be using variety of programs, files, etc., there is a need for organizing and keeping things secured. File permissions session in this lab sheet will help us securing our files and directories in the system.

In this lab sheet, we will also explore a powerful feature used by many command line programs called input/output redirection. We will also look at pipes, a form of redirection used in Linux and other UNIX-like operating systems to send the output of one program to another program for further processing.

2. The *‘cat’* command

cat is one of the most frequently used command on UNIX-like operating systems. It has *three* related functions with regard to text files: creating new ones, displaying them and combining copies of them.

2.1 Creating Files

To create a file ‘***will***’, type the command at the command prompt

```
cat > will
```

and press the enter key. Terminal will wait for input from user. Now type

> **Cowards die many times before their deaths; the valiant never taste of death but once. Of all the wonders that I yet have heard, it seems to me most strange that men should fear; seeing that death, a necessary end, will come when it will come.**

After typing the paragraph above, press ***Ctrl-d***. Once this key combination is typed, UNIX saves the contents typed so far and saves in the file named ‘***will’***.

2.2 Displaying Files

To see the contents of the file created, you can use ***cat*** command (***“vi will”*** will also do) as

```
cat will
```

2.3 Concatenating (Combining) Files

Create one more file named ***“first”*** using ***‘vi editor’*** or ***‘cat’*** command. To concatenate the contents of the two files (***will*** and ***first***) and store the result in the file named ‘***firstwill’***, the cat command is issued as follows:

```
cat first will > firstwill
```

2.4 Exercises

Create a directory ***“Exercises”*** under your home directory. Create two files ***file1*** and ***file2*** under ***“Exercises”*** directory. (Don’t forget to add some text in your files! ☺).

(1) Display the contents of both ***file1*** and ***file2*** in terminal with ***“$”*** at the end of each line.

(2) Display the contents of ***file2*** with the line numbers.

(3) Concatenate contents of ***file1*** and ***file2*** to ***file3***. To distinguish the contents of combining files, include the line numbers for ***file1*** and end each lines of ***file2*** with a “$”.

3. Managing Files

3.1 Copying Files ('cp' command)

Copy command can be used to copy the contents of one file into another file or copy files from one location to another.

***Syntax*:** cp [OPTION1] [OPTION2] ... **SOURCE** **DESTINATION**
*OPTIONS are optional

Options	Purpose
-f	if an existing destination file cannot be opened, remove it and try again
-i	prompt before overwrite
-l	link files instead of copying
-u	copy only when the source file is newer than the destination file or when the destination file is missing
-R or –r	copy directories recursively

- Example:

  To copy the contents of the file ***firstwill*** (source file) into the file ***finalwill*** (destination file), we use the ***cp*** command as follows.

  cp firstwill finalwill

  If the file ***finalwill*** doesn't exist, a new file ***finalwill*** is created in the current directory with the content of ***firstwill***. And if the file exists and is used as the destination of ***cp*** command, the contents of this file will be overwritten.

- If the destination is a directory, the source file is copied into the destination directory with the same name as source. The source and destination can refer to absolute or relative path specification of the file location.

3.2 Moving (and Renaming) File/Directory ('mv' command)

Moving a file/directory means removing it from its current location and copying it to the new location.

***Syntax*:** mv [OPTION1] [OPTION2] ... **SOURCE** **DESTINATION**
*OPTIONS are optional

Options	Purpose
-f	This option replaces the file/directory if it exists already in the destination without prompting to the user. Note that this is the default if the standard input is not a terminal.
-i	This option prompts us, if we are trying to replace a file/directory in the destination.

- **Examples:**
  - ***mv finalwill finalwish***

    Moves file named ***finalwill*** to ***finalwish***. The file named ***finalwill*** will not be available in the system after this operation.
  - ***mv myfile exercises/***

    Moves the file named ***myfile*** to the directory ***exercises***. The file named ***myfile*** will be available inside exercise directory (not in current location).
  - **mv file2 ../**
    Moves the file named ***file2*** to the ***parent*** directory (if write permission is available).
  - ***mv –f first third***

    Moves the file ***first*** to ***third*** in the same directory (location) or it is equivalent to removing ***first*** from the current directory and writes into the current directory as ***third***. **This command has the effect of renaming the file first to third**.

    But what if a file named ***third*** already exists in the current directory?
    The –f specified in the command will replace the existing file ***third*** with the new one. But, the command
    mv –i first third
    will notify you before it attempts to replace the existing file, and will prompt you if you are sure in replacing the existing one. If you type ***n***, it would skip replacing.

    This command can be issued without –f or –i options. In this case, the UNIX system assumes the option is –f. That is, we say the option –f is default option.

3.3 Removing Files and directories ('rm' command)

To remove a file we use the **rm** command.

Syntax: rm [OPTION1] [OPTION2] ... *[filenames | directory]*

Options	**Purpose**
-f	Remove all files (whether write-protected or not) in a directory without prompting the user. In a write-protected directory, however, files are never removed (whatever their permissions are), but no messages are displayed. If the removal of a write-protected directory is attempted, this option will not suppress an error message.
-i	Interactive. With this option, rm prompts for confirmation before removing any files. It overrides the -f option and remains in effect even if the standard input is not a terminal.
-r or -R	Recursively remove directories and subdirectories in the argument list. The directory will be emptied of files and removed. The user is normally prompted for removal of any write-protected files which the directory contains. The write-protected files are removed without prompting, however, if the -f option is used, or if the standard input is not a terminal and the -i option is not used. Symbolic links that are encountered with this option will not be traversed. If the removal of a non-empty, write-protected directory is attempted, the utility will always fail (even if the -f option is used), resulting in an error message.

- **Examples**
  - ***rm help*** To remove a file named ***help***
  - ***rmdir exercises*** To remove a directory named ***exercises***
  - To avoid inadvertently deleting a file, use the ***rm*** command with `-i` option.

    rm -i filename

    This will prompt you to confirm that you want to remove a file from the current directory. Answering **y** will delete the file. The file is not deleted if any other response is given.
  - To remove a directory, we can use the ***rm*** command, but we specify the name of the directory to be deleted instead.

    rm -r directory_name

    This deletes all the contents of the directory including any subdirectories.
    To avoid inadvertently removing a directory, always use the **rm** command with `-i` option.

    rm -ir directory_name

    But if the directory we want to delete is empty, we may use ***rmdir*** command.

3.4 Exercises

Create two sub-directories ***"CP1"*** and ***"CP2"*** under your *home* directory. Create a sub-directory ***"SLIDES"*** and two text files ***"lecture.txt"*** and ***"lab.txt"*** under ***"CP1"*** directory.

Perform the following operations with *home* as your working directory.

(1) Rename ***"lecture.txt"*** file to ***"lec.txt"***.

(2) Copy all text files of ***"CP1"*** directory to ***"CP2"*** directory.

(3) Move ***"CP2"*** directory to a newly created directory ***"Others"*** under your *home* directory.

(4) Rename ***"CP1"*** directory to ***"CP"***.

(5) Create replica of ***"CP"*** directory in your *home* directory and name it as ***"Backup"***.

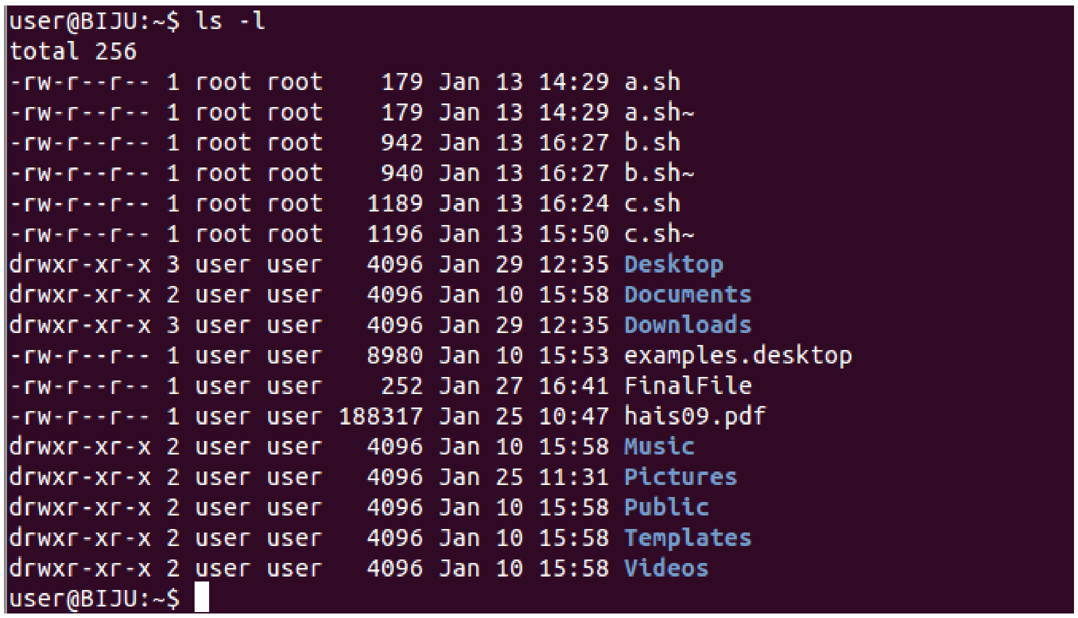
(6) Delete ***"Others"*** directory from your *home* directory.

(7) Create ***"CP2014"*** directory under your *home* directory. Create a file inside ***"CP2014"*** named ***"info.txt"*** with merged contents from ***"lec.txt"*** and ***"lab.txt"*** files of your ***"CP"*** directory.

4. File Permissions

We have seen from Lab00 that ***ls –l*** gives files in long listing format as shown in Figure 1.

The listing includes the total block size (1 block=1024 bytes of memory) of the files in the directory and subdirectories, type and permissions, owner, group, size, date and time of last modification and the names of the files or directories in the current directory.



```
user@BIJU:~$ ls -l
total 256
-rw-r--r-- 1 root root    179 Jan 13 14:29 a.sh
-rw-r--r-- 1 root root    179 Jan 13 14:29 a.sh~
-rw-r--r-- 1 root root    942 Jan 13 16:27 b.sh
-rw-r--r-- 1 root root    940 Jan 13 16:27 b.sh~
-rw-r--r-- 1 root root   1189 Jan 13 16:24 c.sh
-rw-r--r-- 1 root root   1196 Jan 13 15:50 c.sh~
drwxr-xr-x 3 user user   4096 Jan 29 12:35 Desktop
drwxr-xr-x 2 user user   4096 Jan 10 15:58 Documents
drwxr-xr-x 3 user user   4096 Jan 29 12:35 Downloads
-rw-r--r-- 1 user user   8980 Jan 10 15:53 examples.desktop
-rw-r--r-- 1 user user    252 Jan 27 16:41 FinalFile
-rw-r--r-- 1 user user 188317 Jan 25 10:47 hais09.pdf
drwxr-xr-x 2 user user   4096 Jan 10 15:58 Music
drwxr-xr-x 2 user user   4096 Jan 25 11:31 Pictures
drwxr-xr-x 2 user user   4096 Jan 10 15:58 Public
drwxr-xr-x 2 user user   4096 Jan 10 15:58 Templates
drwxr-xr-x 2 user user   4096 Jan 10 15:58 Videos
user@BIJU:~$ 
```

Figure 1) ls –l command output

The words "total 256", indicates that total of 256 blocks is occupied by the files in the disk. Each block contains 1024 bytes of memory.

First column of list identifies the type and permissions associated with each file. Type is identified by first character; it is hyphen ('-') for files and **'d'** for directories. Following the type, a series of 9 characters that can take the values **'r'** (read), **'w'** (write), **'x'** (execute), **'-'** tells about file permissions for three types of users given below respectively.

Each file has a specific permission

1. For the user/owner (u)
2. For the group (g)
3. Others (o)

Each one of them has three permissions

- To read (r) - 4
- To write (w) - 2
- To execute (x) – 1

Note: *A hyphen in any position means that you don't have that particular permission.*

The ***chmod*** command is used to set the three permissions for all three categories of users (owner, group and others) for the file. Only owner of the file can set the access permissions.

Syntax:

chmod [OPTION]... MODE[,MODE]... FILE...
chmod [OPTION]... OCTAL-MODE FILE...

Options	**Purpose**
-c	like verbose but report only when a change is made
-R	change files and directories recursively

Examples:

Command	***Explanation***
chmod u+x will	Execute permission is added to the owner for the file ***will***
chmod ugo+x will *or* chmod a+x will	Execute permission is added to *all* for the file ***will***
chmod o-x will	Execute permission is removed from the others for the file ***will***
chmod g+rx, o+x will	Read and execute permission to group and execute permission to others for the file ***will***

Alternative way to set the file permissions by using numbers:

Command	***Explanation***
chmod 777 will	Read, write and execute permissions to all for the file ***will***
chmod 774 will	Owner and group have all three permissions and others have only read permission for the file ***will***
chmod 400 will	Read permission to the owner for the file ***will*** is set. Group and others don't have any access to the file.

4.1 Exercises

With ***"CP"*** as your working directory, perform the following operations:

(1) Deny all permissions for *others* to the contents of ***"CP2014"*** directory.

(2) Prevent *group* and *others* from modifying the contents of your ***"Backup"*** directory.

(3) Set *all* permissions for the contents of ***"CP"*** directory to *all* three type of users.

5. IO Redirection

Every operating system defines a standard input device and a standard output device. UNIX defines keyboard to be the standard input device and the monitor to be the standard output device. UNIX allows us to temporarily change the standard input and standard output by means of what is called as ***Indirection*** and ***Piping***. The symbol > means indirection of output (to a file or printer) and the symbol < means indirection of input for a command (from a file).

Create a file named ***testfile*** with the following contents:

A person who never made a mistake never tried anything new.

Execute the following command: **cat testfile > file2**

The above command declares ***file2*** as the temporary standard output causing the contents of ***testfile*** to be redirected to ***file2***. Open file2 and check if the contents are the same as that in ***testfile***.

Now re-open the file ***testfile***, change the contents to

A person who is repeatedly committing the same mistake is a fool.

Execute the following command: **cat testfile > file2**

Open file2. Do you still see the earlier contents? If the file file2 is not empty, it will be overwritten. To avoid this, use >>. This appends to the old contents of file2.

Change the contents of ***testfile*** again and execute the command: **cat testfile >> file2**

Open ***file2*** and check if the earlier contents and the currently modified contents are seen in file2. That was about *output indirection*.

Let us now turn to *input indirection*.

What does the command **cat testfile** do?

This command (cat) takes its input from the file named ***testfile*** and displays the result into the standard output. Please note that this command does not take its input from standard input, rather from a file.

Now try the command: **cat < testfile**

What is the result? No surprise. No difference from the previous command. You are getting the contents of the file ***testfile*** in the standard output, but the file ***testfile*** is temporarily the standard input and the command cat gets its input from standard input.

Now try the command: **cat < testfile > op**

What does this command perform? How does it differ from the command **cat testfile > op** ?

The cat command considers ***testfile*** as input and directs it to the file ***op***. Open the file ***op*** and check if the contents are the same as ***testfile***.
(Note: File ***op*** is implicitly created when the indirection command is used.)

The indirection operators are:

Indirection Operators	Function
> *file*	make *file* as the standard output
< *file*	make *file* as the standard input
>> *file*	make *file* as the standard output, append to it if it exists
<< *word*	take the shell input up to the first line containing '*word*'
command1 | *command2*	make the output of *command1* as the input to *command2*

5.1 Exercises

Commands	What does the command do?
$ ls > filelist	
$ date ; who > op	
$ date ; who; ls >op	
$ (date ; who) > op	
$ date; (who ; ls) > op	

---

6. Filters

6.1 File related (filter) commands

Many UNIX programs read some input, perform a transformation on it, and write it to some output. These programs are called *filters* and when used together with pipes can produce powerful programs. Some useful filters are explained below.

---

wc (word count): This command helps in counting the number of lines, words and characters in a specified file.

To get the count for ***file1***, the *wc* command is: **wc file1**

This command will give output in the format: ***<l> <w> <c> file1***

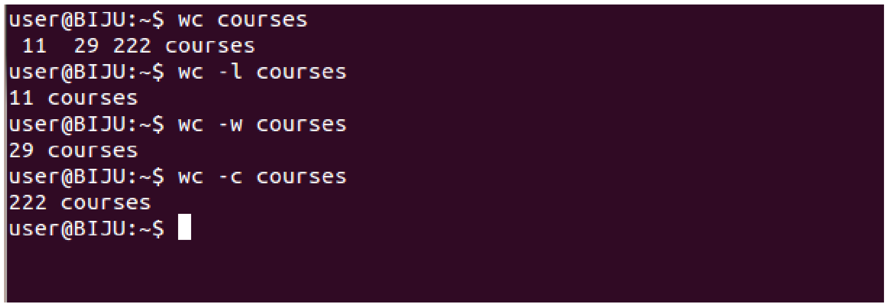
This means the file ***file1*** has *'l'* number of lines, *'w'* number of words and *'c'* number of characters**.**

This command can use options like –l, -w, -c to get the number of lines, words characters individually. The usage will be as follows: **wc –*option* filename**

Example: Create a file named ***courses*** with the following contents:

1. Physics-I
2. Mathematics-I
3. Chemistry-I
4. General Biology
5. Engineering Graphics
6. Workshop Practice
7. Computer Programming
8. Probability and Statistics
9. Thermodynamics
10. Electrical Sciences
11. Chemistry-II

The *wc* command outputs for the file ***courses*** are as shown in figure 2.



```
user@BIJU:~$ wc courses
 11  29 222 courses
user@BIJU:~$ wc -l courses
11 courses
user@BIJU:~$ wc -w courses
29 courses
user@BIJU:~$ wc -c courses
222 courses
user@BIJU:~$ 
```

Figure 2) Output of 'wc' commands

---

sort : This command is used to sort the contents of the file. While sorting the files, this command bases the comparison on the first character in each of the lines. If the first character for two lines is same, then the second character is used in comparison.

To sort the contents in the file ***file1***, the *sort* command is **sort file1**

Example: Create a file named ***file1*** with the following contents:

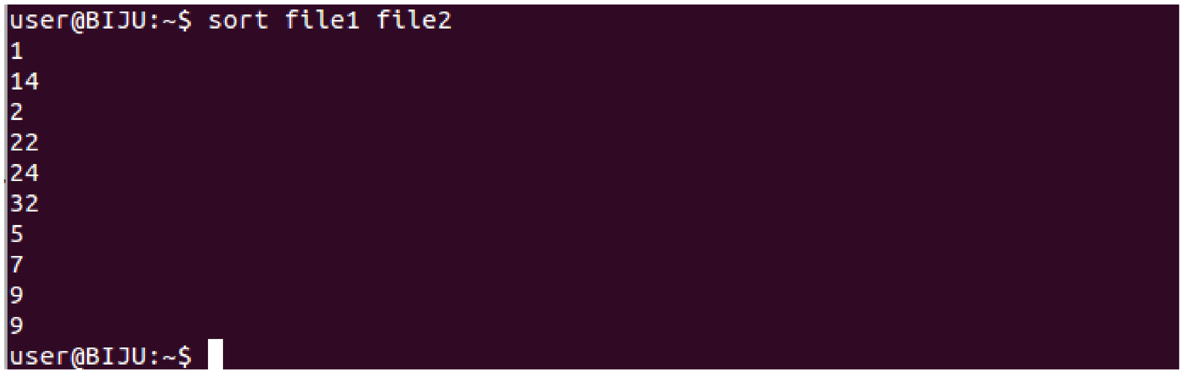
```
9
7
5
1
2
```

Create another file named ***file2*** with the following contents:

```
24
22
14
32
9
```

Execute the following command: **sort file1 file2**

This command will sort the contents of both files at a time (Figure 3).



```
user@BIJU:~$ sort file1 file2
1
14
2
22
24
32
5
7
9
9
user@BIJU:~$
```

Figure 3) Output of "sort file1 file2" command

The general syntax of the sort command is

sort [OPTION] ... [file name]...

The most common flags are as follows:

Option	Comment
-b	Ignore leading blanks
-d	Consider only blanks and alphanumeric characters
-f	Fold lowercase to uppercase characters before sorting (i.e., "Bill", "bill" and "BILL" are treated the same).
-r	Reverse the result of comparisons.
-u	Ignore repeating lines

head : The *head* command reads the first few lines of any text given to it as an input and writes them to the display screen.

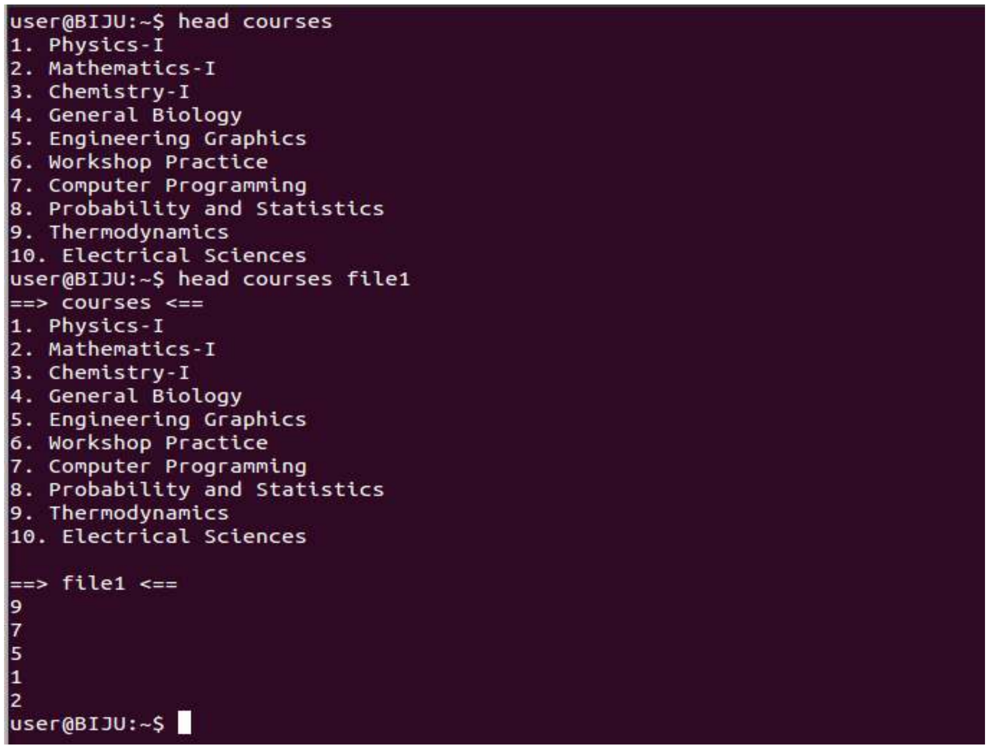
Syntax is: **head [options] [file(s)]**

By default, *head* returns the first ten lines of each file name specified.

Try the following *head* commands for the files created above. (Figure 4)

head courses

head courses file1

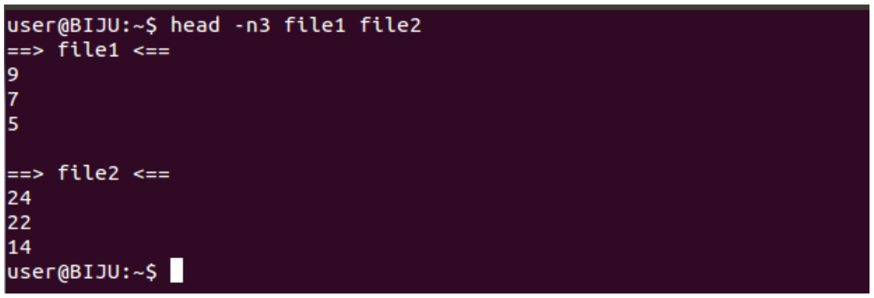


```
user@BIJU:~$ head courses
1. Physics-I
2. Mathematics-I
3. Chemistry-I
4. General Biology
5. Engineering Graphics
6. Workshop Practice
7. Computer Programming
8. Probability and Statistics
9. Thermodynamics
10. Electrical Sciences
user@BIJU:~$ head courses file1
==> courses <==
1. Physics-I
2. Mathematics-I
3. Chemistry-I
4. General Biology
5. Engineering Graphics
6. Workshop Practice
7. Computer Programming
8. Probability and Statistics
9. Thermodynamics
10. Electrical Sciences

==> file1 <==
9
7
5
1
2
user@BIJU:~$
```

Figure 4) Examples of "head" command

We can specify the number of lines to be displayed from the file by using *–n option*. The *-n* option is used followed by an integer indicating the number of lines desired. For example, the above example could be modified to display the first 3 lines from each file: **head –n3 file1 file2**



```
user@BIJU:~$ head -n3 file1 file2
==> file1 <==
9
7
5

==> file2 <==
24
22
14
user@BIJU:~$
```

Figure 5) Output of "head –n3 file1 file2" command

tail: The tail command is similar to the head command except that it reads the final lines in files rather than the first lines.

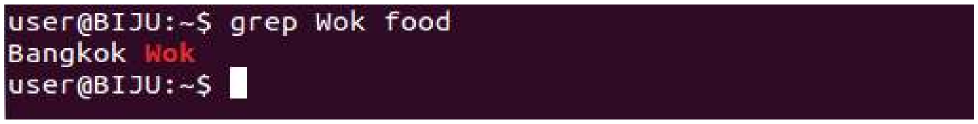
6.2 Grep Command

The UNIX grep command helps you search for strings in a file.

Create a file named "***food***" with the following contents:

```
Afghani Cuisine
Mandalay
Big Apple Deli
Isle of Java
Tio Pepe's Peppers
Sushi and Sashimi
Sweet Tooth
Bangkok Wok
```

To find the lines that contain the string ***"Wok"*** from the file food and display those lines to the standard output, the command is **grep Wok food**

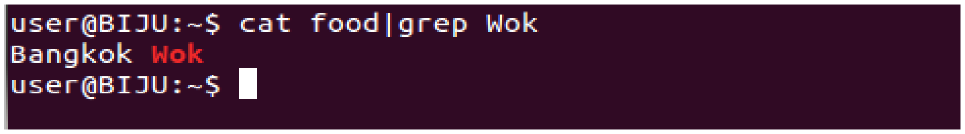


```
user@BIJU:~$ grep Wok food
Bangkok Wok
user@BIJU:~$
```

Figure 6: Result of the command "grep Wok food"

It will display the line(s) containing ***"Wok"*** in the file ***food***. It is done by matching the pattern ***"Wok"*** in the file *food*. (Figure 6).

What is the result of the command **cat food | grep Wok** ?



```
user@BIJU:~$ cat food|grep Wok
Bangkok Wok
user@BIJU:~$
```

Figure 7: Result of the command "cat food | grep Wok"

Here, grep acts as a filter. (Figure 7)

<u>Checking for the given string in multiple files:</u>

Syntax: **grep [OPTIONS] "string" FILE_PATTERN**

The grep output will include the file name in front of the line that matches the specific pattern. When the Linux shell sees the meta-character, it does the expansion and gives all the files as input to grep.

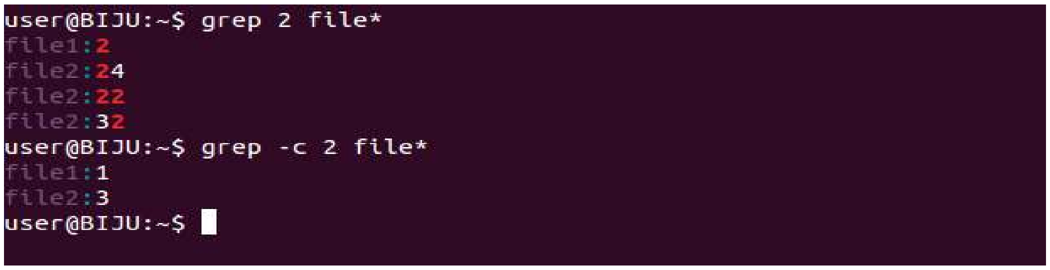
Some options with *'grep'* command include:

Option	Comment
-c	Prints only a count of the lines that contain the pattern.
-i	Ignores upper/lower case distinction during comparisons.
-l	Prints only the names of files with matching lines, separated by NEWLINE characters. Does not repeat the names of files when the pattern is found more than once.
-n	Precedes each line by its line number in the file (first line is 1).
-v	Prints all lines except those that contain the pattern.

Try the following grep commands: (Figure 8)

grep 2 file*

grep –c 2 file*



```
user@BIJU:~$ grep 2 file*
file1:2
file2:24
file2:22
file2:32
user@BIJU:~$ grep -c 2 file*
file1:1
file2:3
user@BIJU:~$
```

Figure 8) Output of "grep" commands

6.3 Exercises

(1) Print the last 8 bytes of the file ***"food"***
(2) Create a file ***"file4"*** with the first 3 lines of ***"file1"*** and the last 2 lines of ***"file2"***
(3) Print numerically sorted contents of "***file2"***
(4) Check if the contents of "***file4"*** are in sorted order or not. If not, save the contents sorted in reverse order with no duplicate entries to "***file5"***.
(5) Display the lines of file "***courses"*** which has the string *"Computer"* along with the line number.
(6) Print the length of the longest line in the file "***courses"***.

7. Piping

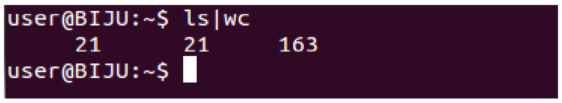
The indirection operator (|) or pipe symbol helps in joining two commands. Now the output from one command becomes the input of the other. Two or more commands connected in this way forms a **pipe**. When a command takes its input from another command, performs some operation on that input, and writes the result to the standard output (which may be piped to yet another program), it is referred to as a filter. Hence the commands that make up the pipe are called **filters**. (Imagine a sequence of pipes, each connected with the adjacent ones by means of a filter).

One of the most common uses of filters is to modify output. Just as a common filter culls unwanted items, the UNIX filters can be used to restructure output. Putting a vertical bar (|) on the command line between two commands makes up a pipe. When a pipe is set up between two commands, the standard output of the command to the left of the pipe symbol becomes the standard input of the command to the right of the pipe symbol.

So, what commands are qualified to become a filter? Simple, if it can take input from standard input and can send its output to standard output, and then it can be a filter.

The command: **ls | wc**

Will execute the ls command first, direct the output to the next command wc. The command wc is executed and the output is shown in the terminal as shown in figure 9.

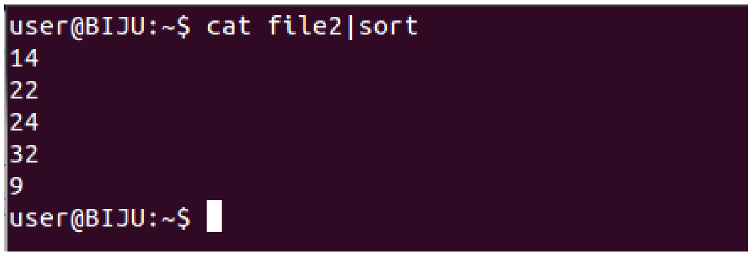


```
user@BIJU:~$ ls|wc
     21      21     163
user@BIJU:~$
```

Figure 9) Result of the command "ls | wc"

Now execute the following command: **cat file2 | sort**

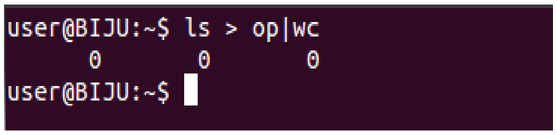
The output of cat command is given as input to the sort command. The result is shown in figure 10.



```
user@BIJU:~$ cat file2|sort
14
22
24
32
9
user@BIJU:~$
```

Figure 10) Result of the command "cat file2 | sort"

Try executing the following command: **ls > op | wc**



```
user@BIJU:~$ ls > op|wc
      0       0       0
user@BIJU:~$
```

Figure 11) Result of the command "ls > op | wc"

Why is the output zero?

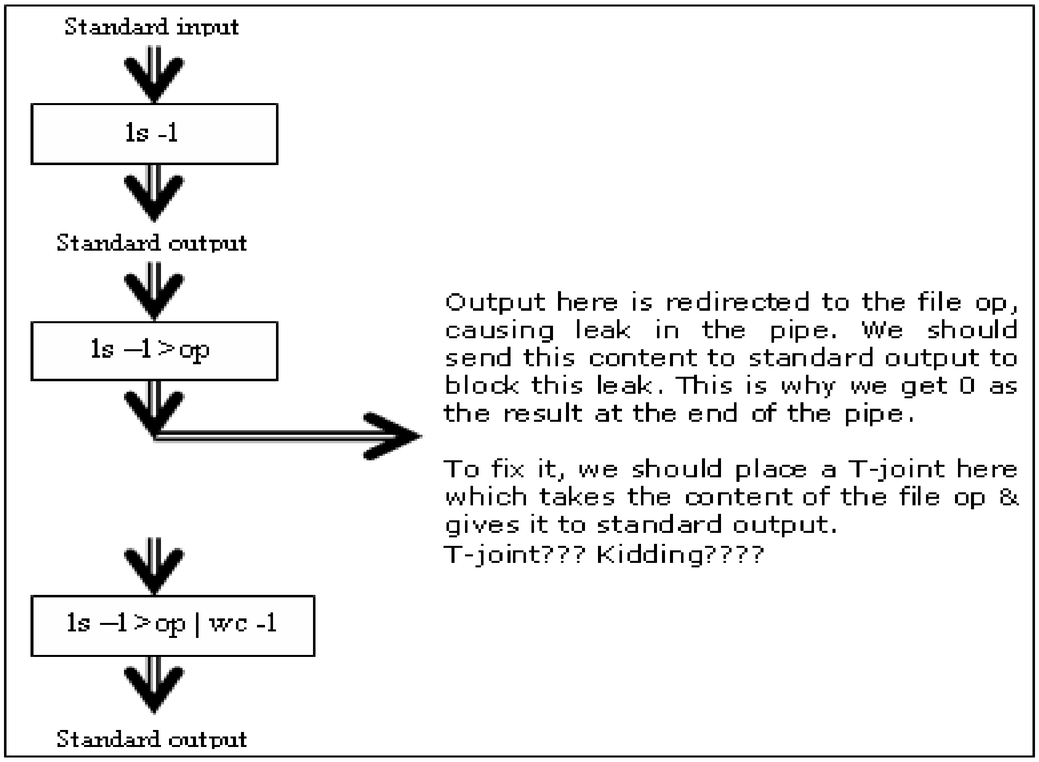

Standard input
ls -l
Standard output
ls –l > op
Output here is redirected to the file op, causing leak in the pipe. We should send this content to standard output to block this leak. This is why we get 0 as the result at the end of the pipe.
To fix it, we should place a T-joint here which takes the content of the file op & gives it to standard output.
T-joint??? Kidding????
ls –l > op | wc -l
Standard output

Figure 12) A damaged pipe

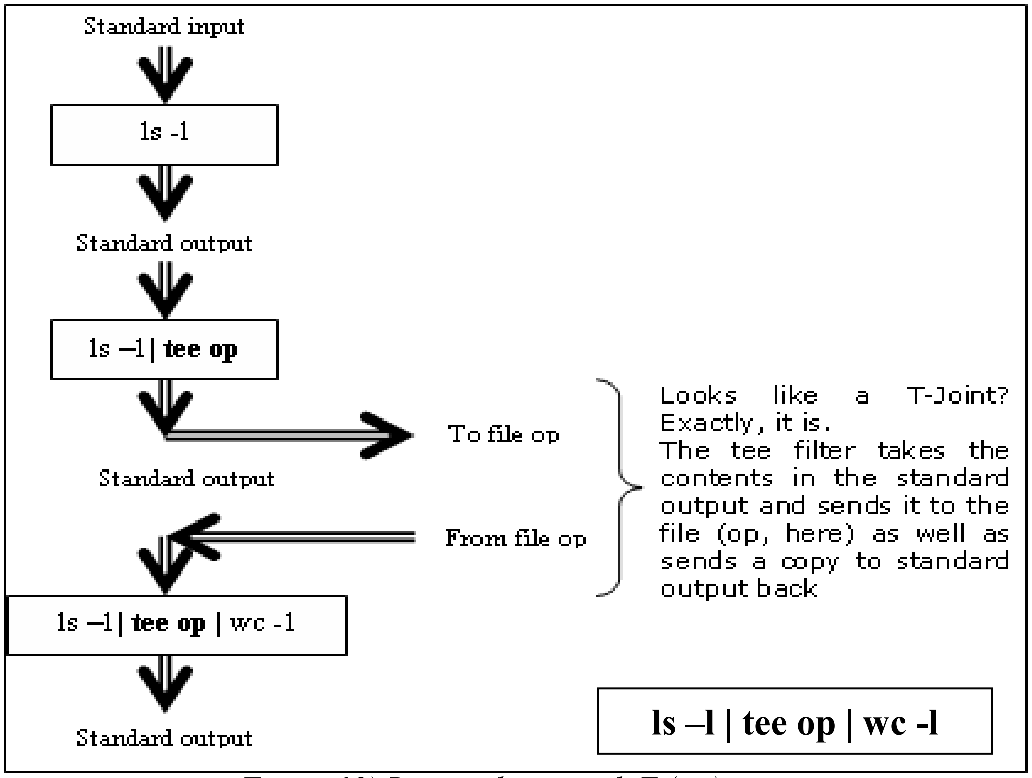

Standard input
ls -l
Standard output
ls –l | tee op
To file op
Standard output
From file op
Looks like a T-Joint? Exactly, it is.
The tee filter takes the contents in the standard output and sends it to the file (op, here) as well as sends a copy to standard output back
ls –l | tee op | wc -l
Standard output
ls –l | tee op | wc -l

Figure 13) Repaired pipe with T (tee) joint

Thus the tee command is used to direct the output to a file as well as the standard output which is the terminal. Now try the command **ls -l |tee op | wc –l**

Does it display the number of lines (wc -l) in the directory listing (ls -l) on the terminal?

7.1 Exercises

Execute the following:

Commands	**What does the command do?**
$ ls | wc	
$ ls > op | wc	
$ ls | wc > op	
$ cat file file file | sort	
$ cat file | sort | head -1 | wc -w	

Solutions to Exercise Questions

Exercise 2.4

```
cd ~
mkdir Exercises
cd Exercises
cat > file1
cat > file2
```

```
(1) cat –e file1 file2
(2) cat –n file2
(3) cat –n file1 > file3; cat –e file2 >> file3
```

Exercise 3.4

```
cd ~
mkdir CP1
mkdir CP2
mkdir CP1/SLIDES
cat > CP1/lecture.txt
cat > CP1/lab.txt
```

```
(1) mv CP1/lecture.txt CP1/lec.txt
(2) cp CP1/*.txt CP2/
(3) mkdir Others; mv CP2 Others/CP2
(4) mv CP1 CP
(5) cp –r CP Backup
(6) rm –r Others
(7) mkdir CP2014
    cat CP/lec.txt CP/lab.txt > CP2014/info.txt
```

Exercise 4.1

```
(1) chmod o-rwx ../CP2014/*
(2) chmod go-w ../Backup/*
(3) chmod 777 *
```

Exercise 6.3

```
(1) tail -8c food
(2) (head -n3 file1; tail -n2 file2) > file4
(3) sort -g file2
(4) sort -c file4
(5) (sort -ru file4) > file5
(6) grep -nw Computer courses
(7) wc -L courses
```