Linux Operating Systems

What is UNIX?

- Unix is the multi-user multitasking Operating System.
- UNIX is an operating system which was first developed in 1960s and has been under constant development ever since.
- By operating system, we mean the suite of the program which make the computer work.
- It is stable, multi-user multi-tasking system for servers, desktops and laptops.
- UNIX systems are also have a graphical user interface(GUI) similar to Microsoft Windows ,which provides an easy to use environment .
- However knowledge of UNIX is required for operations which aren’t covered by a graphical program , or when there are no windows interface available ,for example in a telnet session.

History Of Unix

- In 1969, a team of developers of Bell Labs started a project to make a common software for all the computers and named it as 'Unix'.
- It was simple and elegant, used 'C' language instead of assembly language and its code was recyclable.
- Unix was only found in large organizations like government, university, or larger financial corporations with mainframes and minicomputers (PC is a microcomputer).
- In eighties, many organizations like IBM, HP and dozen other companies started creating their own Unix.
- Then in 1983, Richard Stallman developed GNU project with the goal to make it freely available Unix like operating system and to be used by everyone. But his project failed in gaining popularity
- Many other Unix like operating system came into existence but none of them was able to gain popularity.
- In 1991, Linus Torvalds a student at the university of Helsinki, Finland, thought to have a freely available academic version of Unix started writing its own code.

Connection between C and Unix

- At the time the first Unix was written ,most operating systems developers believed that an operating system must be written in an assembly language so that
  - it could function effectively
  - gain access to the hardware

- Not only Unix was innovative as an operating system it was ground-breaking in that it was written in a language C that was not a assembly language.
- The C language itself operates at a level that is just high enough to be portable to variety of computer hardware.
- A great deal of publicy available Unix software is distributed as C programs that must be compiled before use.
- Many Unix programs follow C syntax
- Unix system calls are regarded as C functions.

Why use Unix?

- One of the biggest reasons for using Unix is networking capability.
- With the operating systems additional software must be purchased for networking.
- With Unix, networking capability is simply part of the operating system
- Unix can run on a variety of hardware . These systems are available from many different sources, some of them at no cost.

Characteristics of Unix

- Unix is ,at its base level, a multi-user ,multitasking virtual memory operating system that runs on a wide variety of hardware platforms.
- This means that Unix is able to do many things at the same time for many different users and using more memory than it really has physically installed.
- ***Unix is a multiuser system***:-This means that inherent to Unix is the idea that are different users of the system , and that different users may have different sorts of privileges and types of access to different parts of the system.
- It allows for the idea that some users may want to protect some of their data from being accessed by other users on the system.
- So ,in being a multi-user system , the basic ideas of the system security and data.

- **Unix is multitasking system**: This means that Unix has the ability to handle more than one task at a time.
- These tasks might be several programs that any particular user wants to run,or they may be programs run by several users at once.
- Multitasking combined with being a multi-user system make it possible for more than one person to be logged-in and Using a Unix System at once.

What is Linux?

- Linux is an operating system (OS).
- We all are familiar with other operating systems like Microsoft windows, Apple Mac OS, iOS, Google android, etc, just like them linux is also an operating system.
- An operating system is a software that enables communication between computer hardware and software.
- It conveys input to get processed by the processor and brings output to the hardware to display it.
- Linux is **open source**.
- The source code is included with the compiled version and allows modification by anyone having some knowledge.
- It gives us freedom to run the program, freedom to change the code according to our use, freedom to redistribute its copies and freedom to distribute copies which are modified by us.

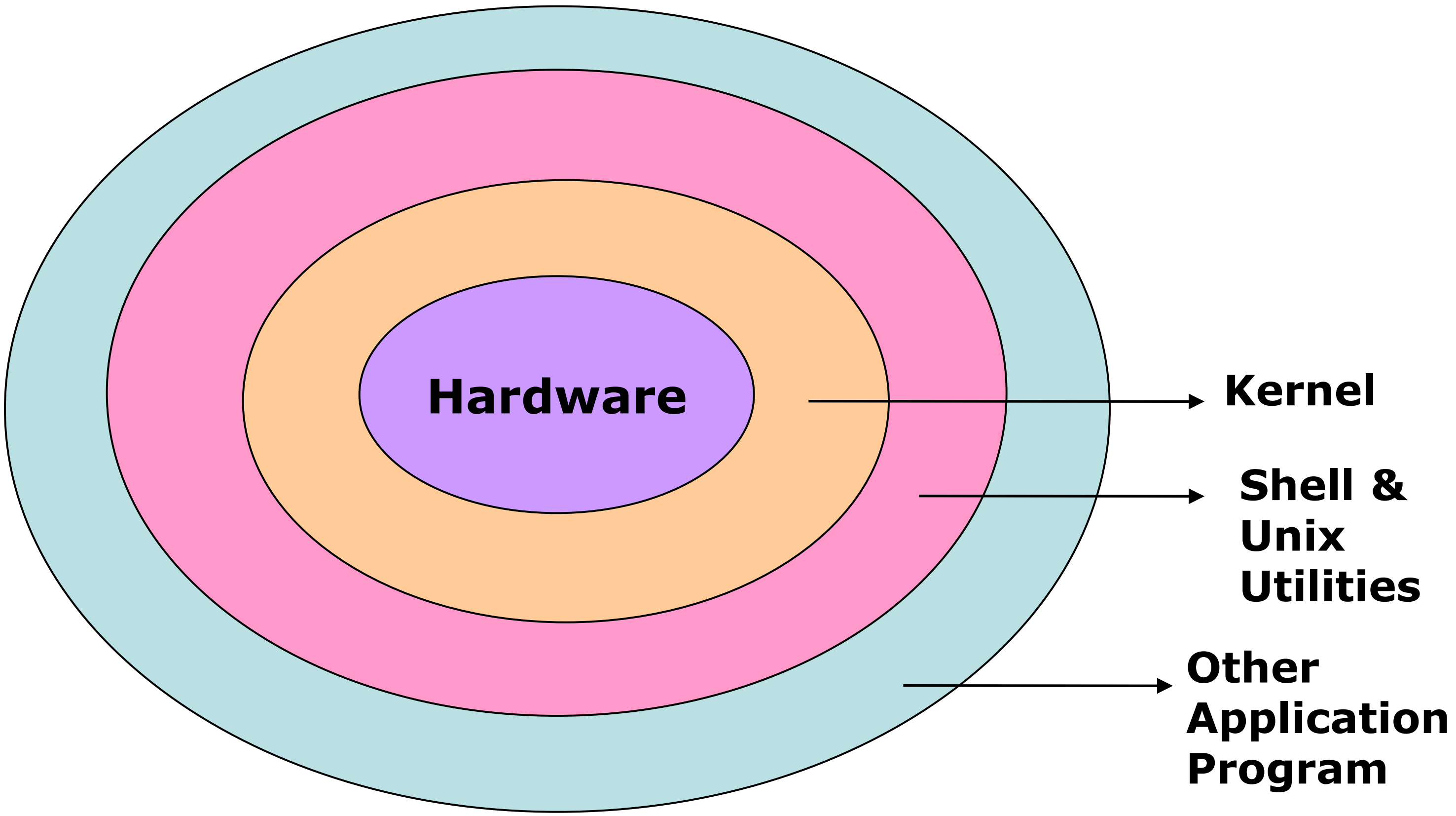
Difference between UNIX and LINUX

Linux	Unix
It is an open-source operating system which is freely available to everyone.	It is an operating system which can be only used by its copyrighters.
Linux is in great demand. anyone can use Linux whether a home user, developer or a student.	It was developed mainly for servers, workstations and mainframes.
Linux is used everywhere from servers, PC, smartphones, tablets to mainframes and supercomputers.	It is used in servers, workstations and PCs
Linux is freely distributed ,downloaded, and distributed through magazines Linux are also cheaper than Windows.	Unix copyright vendors decide different costs for their respective Unix Operating systems.

Why use Linux?

- It is an open source OS which gives a great advantage to the programmers as they can design their own custom operating systems.
- It gives you a lot of option of programs having some different features so you can choose according to your need.
- A global development community look at different ways to enhance its security, hence it is highly secured and robust so you don't need an anti virus to scan it regularly.
- Companies like Google, Amazon and Facebook use linux in order to protect their servers as it is highly reliable and stable.
- Above all you don't have to pay for software and server licensing to install Linux, its absolutely free and you can install it on as many computers as you want.
- Its completely trouble free operating system and don't have an issue with viruses, malware and slowing down your computer.

Unix Architecture



Kernel- is the core part of Linux.

- It is responsible for all major activities of this operating system.
- It is the hub of operating systems it allocates time and memory to programs and handle the file store and communications in response to system calls.
- It consists of various modules and it interacts directly with the underlying hardware.
- Kernel provides the required abstraction to hide low level hardware details to system or application programs.

Shell – Linux provides a special interpreter program which can be used to execute commands of the operating system.

- The shell acts as an interface between the user and the kernel .
- When the user logs in, the login program checks the username and password and then starts another program called shell.
- The shell is a command line interpreter
- It interprets the command the user types in and arranged for them to be carried out.
- The commands are themselves programs when they terminate ,the shell gives the user another prompt.
- The shell keeps a list of the commands you have typed in.
- If you need to repeat a command use the cursor keys to scroll up and down the list or type history for a list of previous commands.

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Linux Features

- **Portability:-**Portability doesn't mean it is smaller in file size or can be carried in pen drives or memory cards. It means that it support different types of hardware.
- **Security:-**It provides security in three ways namely authenticating (by assigning password and login ID), authorization (by assigning permission to read, write and execute) and encryption (converts file into an unreadable format).
- **Open-Source:-:-**Linux code is freely available to all and is a community based development project.
- **File System:-**Provides hierarchical file system in which files and directories are arranged.
- **Multiuser capability:** Multiple users can access the same system resources like memory, hard disk, etc. But they have to use different terminals to operate.

Linux Distributions

- There are many Linux distributors providing different features.
- **Ubuntu**:-It came into existence in 2004 , easy graphical Linux desktop without the use of command line. It is the most well known Linux distribution. It comes with a lots of pre-installed apps and easy to use repositories libraries.
- **Linux Mint**:-Mint is based on Ubuntu and uses its repository software so some packages are common in both.
- **Debian**:-Debian has its existence since 1993 and releases its versions much slowly then Ubuntu and mint. This makes it one of the most stable Linux distributor.
- **Red Hat Enterprise / CentOS:-**Red hat is a commercial Linux distributor. There products are red hat enterprise Linux (RHEL) and Fedora which are freely available. RHEL is well tested before release and supported till seven years after the release, whereas, fedora provides faster update and without any support.
- **Fedora**:-It is a project that mainly focuses on free software and provides latest version of software. It doesn't make its own desktop environment but used 'upstream' software. It is less stable but provides the latest stuff.

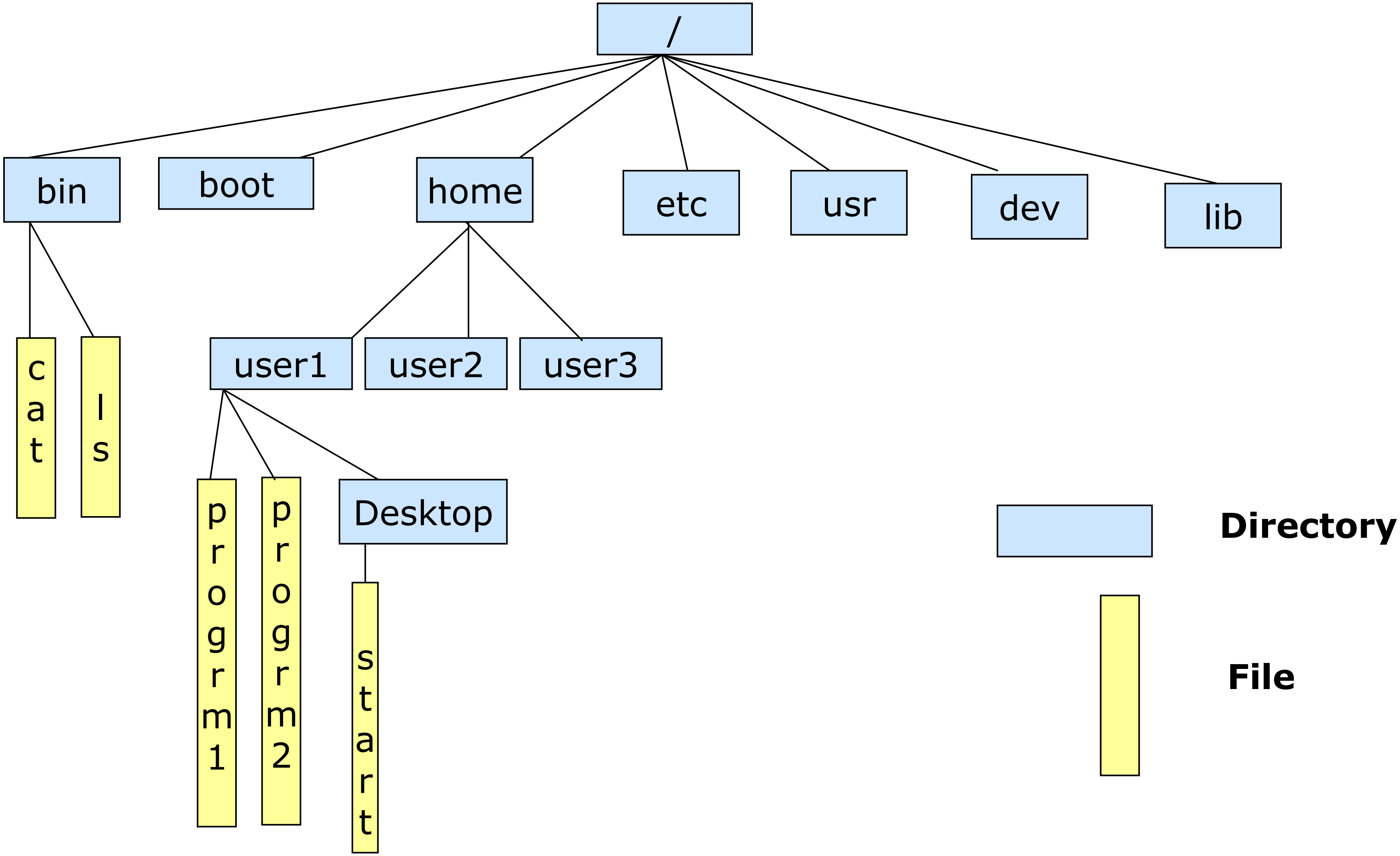
Files and processes

- Everything in UNIX is either a file or process.
- A process is executing program identified by a unique PID(process identifier)
- A file is a collection of data
- They are created by users using text editors , running compilers etc.
- Examples of files:
- A document(report ,essay)
- The text of a program written in some level high-level programming language

Directory Structures

- All the files are grouped together in the directory structure.
- The file-system is arranged in a hierarchical structure like an inverted tree.
- The top hierarchy is traditionally called root (written as slash/)

Directory Structure



Linux Directories

- **What are Commands?**
- A command is an instruction given to our computer by us to do whatever we want. In Mac OS, and Linux it is called terminal, whereas, in windows it is called command prompt. Commands are always case sensitive.
- This command further passes to the shell which reads the command and execute it.
- Shell is a method for the user to interact with the system.
- Default shell in Linux is called bash (Bourne-Again Shell).
- There are two types of shell commands:
- **Built-in shell commands:** They are part of a shell. Each shell has some built in commands.
- **External/Linux commands:** Each external command is a separate executable program written in C or other programming languages.

Linux Commands

- **pwd**:-The pwd command stands for (print working directory). It displays the current working location or directory of the user. It displays the whole working path starting with /. It is a built-in command.
- **ls**:-The ls command is used to show the list of a folder. It will list out all the files in the directed folder.
- **cd**:-The cd command stands for (change directory). It is used to change to the directory you want to work from the present directory.
- **mkdir**:-With mkdir command you can create your own directory.
- **rmdir**:-The rmdir command is used to remove a directory from your system.
- **Cal**:-shows the calendar

- **who**:-Shows who is logged on

  who am I

  Shows the login name of the current user

Linux Commands

- **du:** to view the space
- **df:** to view the file storage space used
- **uname:-**to view the system used
- **Hostname:-**to check your hostname
- **Date**:-prints the system date
- **echo**:-command to print a message
- Exit:to exit from shell

bc command

- **bc** command is used for command line calculator. It is similar to basic calculator by using which we can do basic mathematical calculations.

1) echo "12+5" | bc

- Output : 17

2) echo "10^2" | bc

- Output : 100

Linux File Structures

- In Linux system, everything is a file and if it is not a file, it is a process.
- A file doesn't include only text files, images and compiled programs but also include partitions, hardware device drivers and directories.
- Linux consider everything as a file.
- Files are always case sensitive.

Types of Files:

- **Regular files**
- **Directory files**
- **Device File**
- **Symbolic Links**

Regular Files

- Contains text, data, or program information
- Cannot contain another file or directory
- Can be thought of as one-dimensional array of bytes

Directory File

- Contains directory(s) and/or file(s) within it.
- Has one line for each item contained within the directory.
- Each line in a directory file contains only the name of the item, and a numerical reference to the location of the item, called inode number.
- Inode number is an index to a table known as the inode table.
- Inode stores all information about the file except its name.

Device File

- Physical devices (printers, terminals etc) are represented as “files”.

- The read() and write() functions used to read and write ordinary files can also be used to read from and write to these devices.

- Two types of device files:
  1. Character Special
  2. Block Special

Symbolic Link

- Links make the same file available in multiple directories at the same time
  - Two types of Links:
    1. Hard Link
    2. Soft Link or Symbolic Link

    1. Hard Link
       - A hard link is another name given to the existing file
       - These names share the same inode
       - UNIX command ln is used to create hard links:
         ln file1 file2
    2. Soft Link
       - A soft link to a file has a separate inode than the file
       - It stores the target file’s path in its inode
       - LINUX command ln –s is used to create soft links:
         ln –s file1 file3

INODE

- Inode is a data structure containing useful information about an item in the Unix File System.

- Inodes reside on disk and do not have names.
- Instead, they have indices (numbers) indicating their positions in the array of inodes

Pathnames

- Every item in the file system with a name can be specified with a pathname.

- Pathname represents the path to the entry from the root of the file system.
- By following this path, the system can find the inodeof the referenced entry.

- Pathnames can be absolute or relative.

Linux File Commands

file	Determines file type.
touch	Used to create a file.
rm	To remove a file.
cp	To copy a file.
mv	To rename or to move a file.
rename	To rename file.

- file <filename>
- touch <filename>
- rm<filename>
- cp **<existing** file name**> <new** file name**>**
- mv file1 new-file

Creating File Using cat command

- Cat >filename
- Now you can type in your text.
- Press <Enter> key to start a new line
- When you have finished typing in your text,
- enter Ctrl-d(Press and hold down the Ctrl key and type ”d”)
- This stops the cat command and returns you to the system prompt
- To combine and both the files also we can use cat command
- **cat file1.txt file3.txt**

Creating files using echo

- To create a file type the command **echo** and then continue to type the text that you want to appear in the file.
- When you have finished typing in your text type
- name_of _the_ file
- Example:-   **echo welcome to linux > myFile.txt**
- And press the <Return>key
- This method is useful for creating short files containing only one or two lines of text
- Example
- To create a file with the echo command
- Echo use an editor for large files>tips
- This creates a file called tips in the current directory containing a single line of text.

Displaying files

- Viewing a file
- The cat command is useful for displaying short files of a few lines.
- To display loner files use an editor or pager
- To display the contents of a file use the command
- **cat filename**
- Example
- To display a file
- **cat README**
- This displays the content of the file README.
- If the file contains more lines than can be displayed on the screen at once it will scroll.

UNIX Users

- Super User
- Owner
- Group
- Others

UNIX Users

- Super User
  - Can also be referred to as a System Administrator
  - Has an overall authority on Unix OS
  - Responsible for OS maintenance, backup and recovery, user management etc.
  - Super user login is root and prompt is #

- Owner
  - Is a user who creates a file
  - For every Unix file there can be only one owner
  - File owner can assign the file permissions to group and other users

UNIX users

- Group
  - In Unix, groups can be formed based on area of work
  - SuperUser can create a group and assign members to it
  - Owner of a file can decide what permissions to be given to group members
- Others
  - User who is not a owner and does not belong to any specific group is referred to as other user
  - Owner of a file can decide what permissions to be given to other users

Filters

- wc: counts lines, words and characters
- sort: ordering text files according to the lines.
- tac:-It will display the file content in reverse order.
- head:-The 'head' command displays the starting content of a file. By default, it displays starting 10 lines of any file.
- tail:-The 'tail' command displays the last lines of a file. By default, it will also display the last ten lines of a file
- Syntax:
- **wc filename.txt**
- **tac filename.txt**
- **sort filename.txt**
- **head filename.txt**
- **tail. filename.txt**

Changing access permissions

- To change the access permissions for a file or directory use the command
- **chmod mode filename**
- **chmod mode directory_name**
- **The** “mode” consists of three parts:
- who the permissions apply to,
- how the permissions are set and
- which permissions to set.
- command is used to change the permissions on a file for owner, group and others

  chmod <permission><filename>

Changing access permissions using the chmod command

- Symbolic Method:

Code	Meaning
a	all
u	user
g	group
o	other
+	add
-	remove
=	assign
r	read
w	write
x	execute

chmod u+x file1 -> give yourself permission to execute a file that you own.
This give you execute permissions to read a file. “file1”

chmod g+r file2 -> To give members of your group permission to read file “file2”
This gives the group permission to read the “file2”

chmod a+r *.txt, -> To give everyone read permission to read all the files with the extension .txt

- Absolute value Method:

Code	Meaning
4	Read
2	Write
1	Execute
0	no permission

- chmod 754 sample.txt
- So **7** is the combination of permissions **4+2+1** (read, write, and execute),
- **5** is **4+0+1**(read, no write, and execute),
- and **4** is **4+0+0** (read, no write, and no execute).

Linux Man Command

- The "man" is a short term for manual page.
- man is an interface to view the system's reference manual.
- A user can request to display a man page by simply typing man followed by a space and then argument.
- Syntax man keyword
- Example **man ls**

grep command

- The grep filter searches a file for a particular pattern of characters, and displays all lines that contain that pattern.
- The pattern that is searched in the file is referred to as the regular expression (grep stands for globally search for regular expression and print out).
- Syntax
- **grep [options] pattern [files]**

- **Options Description –**
- **-c** : This prints only a count of the lines that match a pattern
- **-h :** Display the matched lines, but do not display the filenames.
- **-i :** Ignores, case for matching
- **-l :** Displays list of a filenames only.
- **-n :** Display the matched lines and their line numbers.
- **-v :** This prints out all the lines that do not matches the pattern
- **-w :** Match whole word
- **-o :** Print only the matched parts of a matching line, with each such part on a separate output line.

1 **Case insensitive search :** The -i option enables to search for a string case insensitively in the give file

```
grep -i "UNix" file.txt
```

2 **Displaying the count of number of matches :-**We can find the number of lines that matches the given string/pattern

```
grep -c "unix" file.txt
```

3 **Display the file names that matches the pattern**

We can just display the files that contains the given string/pattern.

```
grep -l "unix" *
```

4 Checking for the whole words in a file

```
grep -w "unix" file.txt
```

5. Displaying only the matched pattern : By default, grep displays the entire line which has the matched string.

We can make the grep to display only the matched string by using the -o option.

```
grep -o "unix" file.txt
```

6. Show line number while displaying the output using grep -n

To show the line number of file with the line matched.

```
grep -n "unix" file.txt
```

7. Matching the lines that start with a string :

The ^ regular expression pattern specifies the start of a line. This can be used in grep to match the lines which start with the given string or pattern.

```
grep "^unix" file.txt
```

- **8 Matching the lines that end with a string :** The $ regular expression pattern specifies the end of a line. This can be used in grep to match the lines which end with the given string or pattern.
- **grep "os$" file.txt**

VI EDITOR

- The vi editor is available on all LINUX systems
- It is a very powerful application.
- **Operating modes:**
- There are two modes in which you use vi:
- **Command mode:-** In command mode, actions are taken on the file. The vi editor starts in command mode. Typed words will act as commands in vi editor. To pass a command you have to be in command mode..
- **Insert mode**: n insert mode, entered text will be inserted into the file. **Esc** key will take you to the command mode from insert mode.
- **By default, vi editor starts in command mode. To enter text, you have to be in insert mode, just type 'i' and you'll be in insert mode**

About vi Commands

- While not entering text you see vi in command mode and enter editing commands consisting of one or more characters.
- The syntax of an editing command is:
- Operator object
  - The operator is character such as d for delete that describes the action to be carried out on the object a word sentence paragraph or section
  - To return to command mode from insert mode press the ESC key

Using vi

- The vi editor tool is an interactive tool as it displays changes made in the file on the screen while you edit the file.
- In vi editor you can insert, edit or remove a word as cursor moves throughout the file.
- The vi editor is case-sensitive. For example, **p** allows you to paste after the current line while **P** allows you to paste before the current line.
- **vi syntax:**
- vi **<fileName>**
- To open an existing file for editing
  - vi filename
  - This opens the file for editing. The file already exits in the current directory

Saving files and exiting vi

:wq	Save and quit
:w	Save
:q	Quit
:w fname	Save as fname
ZZ	Save and quit
:q!	Quit discarding changes made
:w!	Save (and write to non-writable file)

Viewing a file

- You can look at a file without the risk of altering its contents by using vi in ”read only” mode.

To do this use the command:

```
view filename
```

The message is displayed at the bottom of the screen.

Moving around the text

- There are a range of easy to use commands that provides a great degree of flexibility in how you move around the contents of the file you are editing.
- Move the cursor along a line
- Press ESC key to enter command mode before using these commands

To move to	Do this…
Next character	I
Previous character	h
Next word	w
Previous word	b
End of current word	e
Start of line	0
End of line	$

- **Move the cursor between lines**
- Next line down j
- Start of the nextLineDown +
- Previous line k
- Start of previous line -
- **Move between text blocks**
- beginning of next sentence)
- beginning of previous sentence (
- beginning of next paragraph }
- beginning of next sentence {
- **To move over the file**
- Top of the file 1G
- Bottom of the file G

Entering text

- To type text into the buffer you must enter insert mode.
- Choose the command that is best suited to the present position of the cursor and the editing task you want to do
- As the text you are typing in begins to approach the right-hand side of the screen press<RETURN> to start a new line.
- As you are entering text, make sure that each sentence ends with a full stop followed by two or more spaces.
- You can then be sure of using vi's editing commands to manipulate the sentences in your text.
- If necessary use vi's global replace command to change sentence endings that do not ,meet this convention.

List of commands

- Insert text after the cursor -   a
- Insert text before the cursor - i
- Append text at the end of the current line –A
- Insert text at the start of the current line – I
- Open a new line below the current line –o
- Open a new line below the current line-O

Changing text around

- There are several ways in which you can change the structure and the content of the file you are editing.
- Repeat parts of the text
- To insert the contents of another file use the command
- :r filename
- This inserts the file immediately after the current line.

Moving around the text

- There are range easy to use commands that provide a great degree of flexibility in how you move around the contents of the file you are editing.
- Many of these commands can be combined with a numerical value to extends their functionality.
  - Move the cursor along the line
  - Press the ESC key to enter command mode before using these commands

To move	Do this
Next character	l
Previous character	h
Next word	w
Next n words	wn
Previous word	b
Previous n words	bn
End of the current word	e
Start of the current line	0(zero)
End of the current line	$

Deleting text

- Text is deleted by combining the delete commands x and d with the type of text object to be deleted.
- Numbers can also be used with both the x and d commands to delete multiple instances of a text object .
- For example:
- 5dw
- This deletes the current word and the following four words:
- Deleting characters
  - Press the ESC key to enter the command mode before using these commands.

To delete	Do this
Current character	x
Previous character	dh

- Deleting words and lines
- Press the ESC key to enter command mode before using these commands

To delete	Do this
Current word	dw
Previous word	db
Entire line	dd
To end of line	d$
To start of line	d0(zero)
Next n lines	ndd

- **Deleting sentences and paragraphs**
- Press the ESC key to enter command mode before using these commands

To delete	Do this
To end of sentence	d)
To beginning of sentence	d(
To end of paragraph	d}
To beginning of paragraph	d{

- **To get back a word or line that you have just deleted enter command p**

Searching text

- Press the ESC key to enter command mode before using these commands

To search	Do this…
Forward for a pattern	/pattern <RETURN>
Backward for a pattern	?pattern<RETURN>

- Examples
- /hello — Searches forward for the word hello.
- ?goodbye — Searches backward for the word goodbye.

Replacing text

- Press the ESC key to enter command mode before using these commands

To replace	Do this..
Pattern1 with pattern2	:s/pattern1/pattern2 on the same line
Every occurrence of pattern1	:g/pattern1/s//pattren2/g with pattern2