

Linux Programming

Symbols

- . : current directory you are in
- ..: parent directory of the current one
- ~ :
 - the logged in user's home directory
 - the user home directory will always start with /home/
 - the home directory for user user1 is /home/user1

File System

- a logical way to organize the files on the disk
- file system path
 - way to locate a file on the disk
 - address of the file on the disk
 - types
 - **absolute path**
 - always starts with root (/)
 - never changes
 - e.g.
 - /etc/hostname
 - **relative path**
 - path relative to the current directory
 - changes as you change the current directory
 - e.g.
 - c.d.: /home/sunbeam => ../../tmp
 - c.d.: /home/sunbeam/Desktop => ../../tmp
- **Everything in unix/linux is a file** even directory is also a type of file even device is also a type of file

Linux Shell

- program used to interact with the OS
- e.g.
 - sh: shell
 - bash: bourne again shell
 - ksh: K shell
 - csh: C shell
 - zsh: Z shell

Editor

- program with which one can edit a file
- types
 - GUI
 - gedit: GNU Editor
 - CUI
 - vi:
 - vim:
- **vim**
 - modes
 - view mode
 - does not allow editing the file
 - default mode
 - use escape to switch to view mode
 - shortcuts
 - **navigation**
 - h: go to left
 - j: go down the file
 - k: go upwards
 - l: go to right character by character
 - w: go to the next word
 - 3w: go to the 3rd word in forward direction
 - b: go to the previous word
 - 5b: go the 5th word in backward direction
 - }: go to the next paragraph
 - 3}: go to the 3rd paragraph in forward direction
 - {: go to the previous paragraph
 - 3{: go to the 3rd paragrapn in backward direction
 - gg: go to the begining of the file
 - G: go to the end of the file
 - \$ (shift + 4): go to the end of the line
 - ^ (shift + 6): go to the begining of the line
 - **editing**
 - o: to add a new blank line
 - yy: copy current line
 - yw: copy current word
 - p: paste on the next line
 - P: paste on the previous line
 - u: undo
 - ctr + r: redo
 - dd: delete (copies the contents in the memory)

- dw: delete a word (copies the word in memory)
- **close**
 - q: to quit
 - q!: close without saving the changes
 - wq: close after the changes are saved
 - w: write the contents
- insert mode
 - allows inserting/editing contents
 - use i to enter into insert mode
- visual mode
 - user will get the visual feedback
 - from view mode use v to go into visual mode
 - use arrow keys to select the content
 - use y to copy or d to cut
 - use p to paste the copied contents

Linux Commands

- action user wants to perform
- types
 - internal
 - part and parcel and of shell
 - the code for these commands is implemented inside the shell
 - one may not find an executable for these commands
 - e.g. cd
 - external
 - generally, these commands are located under /usr/bin
 - one may find an executable for these commands
 - e.g. mkdir, ls

Package manager

- used to manage the packages
- e.g.
 - debian: aptitude
 - red hat: yum
 - alpine: apk

System information

- **date**: displays the current date, time and timezone
- **cal**:
 - displays the calendar for current month

- use year as command line argument to display calendar for entire year
 - cal 2020
 - cal 2019
- **uptime:** shows the time the machine is up from last reboot
- **whoami:** displays the currently logged in user
- **who:**
 - displays the list of currently active users
 - includes all the SSH sessions
- **w:**
 - displays the currently active users along with some other information like uptime
 - includes all the SSH sessions
- **hostname:**
 - displays the host name of the machine
 - the hostname is stored in a file `/etc/hostname`
- **hostnamectl:**
 - displays more information about the hostname
 - e.g.
 - Static hostname
 - OS version
 - virtualization
- **uname:**
 - displays information about the OS (along with distribution)
 - `uname`: type of OS
 - `uname -r`: kernel version
 - `uname -a`: shows all the information
- **lsb_release:**
 - displays the distribution specific information
 - includes
 - distribution ID
 - description
 - codename
 - release (version)
- **df:**
 - disk free
 - displays the disk usage
 - `df -h`: print the info in human readable format

- **du:**
 - disk usage
 - displays the size of every folder and file in the current directory
 - du -h: displays the size in human readable format
 - du -s: displays summary
 - **free:**
 - displays the information about the memory
 - free -h: displays in human readable
 - **whereis:**
 - displays the path and manual file (help) of the executable
 - **which:**
 - displays the path
 - **finger:**
 - displays full information of all active users
 - finger <username>: displays full information of the user
 - **man:**
 - manual: used to get help about any command
 - **Files:**
 - /proc/cpuinfo: contains h/w information about cpu
 - /proc/meminfo: contains information about memory
 - /proc/filesystems: contains the information about the Fses supported by the OS
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Package management

- **apt-get:**
 - apt-get install:
 - installs a package on the machine
 - apt-get update:
 - will update the apt-cache
 - **dpkg:**
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File management

- **ls:**
 - used to list the contents of a directory
 - ls -l: to display in list format
 - ls -a: include hidden files as well

- **pwd:**
 - displays the absolute path of current directory
- **mkdir:**
 - used to create a new directory
 - mkdir -p: create the directories by following the path
 - e.g.
 - mkdir -p dir1/dir2
 - dir1
 - dir2
 - mkdir d1 d2 d3: creates 3 directories named d1, d2 and d3
- **cd:**
 - used to change the directory
- **rm:**
 - used to delete a file
 - rm -r: used to delete a directory
- **tree:**
 - used to display the contents using tree like structure
 - to install tree: sudo apt-get install tree
- **touch:**
 - used to create an empty file
- **file:**
 - displays file type
- **cp:**
 - copy a file from one location to another
 - syntax:
 - cp <source> <destination>
 - cp -r: used to copy a directory from one location to another
- **mv:**
 - moves a file or directory from one location to another
 - syntax: mv <source> <destination>
 - used to rename a file
 - syntax: mv <old file name> <new file name>
- **cat:**
 - used to display the contents of a file

- **less:**
 - used to display the contents of a file using scroller
 - **more:**
 - used to display the contents of a file using scroller
 - **head:**
 - displays first few lines of the file
 - **tail:**
 - displays last few lines of the file
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Permissions

- linux is the most secure OS
- there are three permissions
 - read (r)
 - allows entity to read the contents
 - number: 4
 - write (w):
 - allows entity to write the contents
 - number: 2
 - execute (x):
 - allows entity to execute the contents
 - number: 1
- in linux the permission are given in
 - user: owner of the file
 - group: for group members
 - others: for other user who are not part of the owners group
- e.g.
 - rwx rw- ---
 - owner (user): can read, write and execute
 - group: can read and write
 - others: can not do anything with the file
- **chmod:**
 - used to change the file permissions
 - e.g.
 - chmod ugo+rw file1
 - chmod 666 file1

- **chown:**
 - used to change the ownership of a file/directory
 - **being a directory owner you can create a file inside it**
 - **being a file owner you can read/write/execute a file**
 - **chroot:**
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User management

- every user has an uid
 - uid is used to identify every user uniquely
- every user has a gid
 - gid is group id the user belongs to
- types
 - root: special user who is allowed to perform the administration tasks
 - users
 - allowed to perform user level tasks
 - can gain the root permissions by using sudo command
- the basic information about every user is stored in a file `/etc/passwd`
 - format
 - username
 - password (shifted to `/etc/shadow` file)
 - userid (uid)
 - groupid (gid)
 - user info (name, office number etc)
 - home directory
 - login shell
- the user's password are stored in a file `/etc/shadow`
 - format of the `/etc/shadow`
 - username
 - password
 - groupid
- **group**
 - all the groups in linux are stored in a file `/etc/group`
 - every user may belong to multiple groups
 - primary
 - secondary
- **to create a new user**

- `sudo useradd ironman`
- `sudo passwd ironman`
- `sudo usermod -s /usr/bin/bash ironman`

- **id**

- displays the user information
- userid (uid) and groupid (gid)

- **passwd**

- used to change the current user's password
- `sudo passwd`
 - allows to change the password for other user

- **su**

- used to switch user

- **useradd:**

- used to add a user

- **adduser:**

- used to add a user

- **groupadd:**

- used to create a group

- **addgroup:**

- **usermod:**

- allows to modify the user information
- `-s`: used to change the login shell
- `-a`: used to append to existing groups
- `-G`: adds the user to other groups
- `-g`: sets the user's primary group

- **userdel:**

- **deluser:~~~~**

- used to delete a user
- `--remove-home`: used to delete the home directory

- **groupdel**

- **delgroup**

- used to delete a group

Archiving and unarchiving

- **Archiving**

- create a new file combining multiple files together
- used to take a backup

- **Unarchiving**

- extract the files added in an archived file
- used to restore a backup

- **tar:**

- tape archive
 - c: create archive
 - v: verbose (show the output everytime a file is added to the archived file)
 - f: file name
 - x: unarchive
 - j:
 - to compress at the time of archiving or decompress at the time of unarchiving
 - uses bzip2 for compress and decompressing the files
 - z:
 - to compress at the time of archiving or decompress at the time of unarchiving
 - uses gzip for compress and gunzip decompressing the files

Compression and decompress

- **zip:**

- used to compress the files

- **bzip2:**

- used to compress and decompress the files
- -k: to keep the original file
- -z: to compress the file
- -d: decompress the file

- **unzip:**

- used to decompress a file
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Basic Networking

- **ifconfig:**

- used to get the network information
 - ip address
 - ip4: 32 bit
 - ip6: 128 bit
 - mac address
 - netmask (subnet mask)
 - broadcast ip address

- if not available install it by using

```
sudo apt-get install net-tools
```

- **ping:**
 - used to check the connectivity between two machines
 - e.g. ping google.com
 - **dig:**
 - used to get the DNS record for a domain name
 - e.g. dig google.com
 - **curl:**
 - console url
 - get the html from a url
 - e.g. curl google.com
 - **elinks:**
 - similar to the GUI browser
 - e.g. elinks google.com
 - **wget:**
 - used to download file(s) from internet by using url
 - e.g. wget <url>
 - **traceroute:**
 - used to check the hops in between the machine and the destination
 - e.g. traceroute google.com
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Disk management

- **lsblk:**
 - lists the block devices connected to the machine
- **dd:**
 - used to create disk
 - used to replicate a disk/partition
 - e.g.
 - ```
dd if=/dev/zero of=mydrive bs=1024K count=100
```
    - where
      - if: input
      - of: output file
      - bs: block size
      - count: no of blocks created inside the file
- **mkfs:**
  - used to initialize the FS on the disk
- **mount:**
  - used to mount a drive
  - the directory used to mount a drive is called as mount point
  - e.g. sudo mount -t ext4 <drive> <mount point>
- **umount:**

- used to unmount the mounted drive
  - e.g. `sudo umount <mount point>`
  - **fsck:**
    - check the FS for errors
  - **fdisk:**
    - used to partition the disk
    - `-l`: list of partitions
  - **tune2fs**
    - used to tune the fsck process
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## Shortcuts for terminal

- **ctrl + c:**
    - to break/stop the current
  - **up arrow:**
    - to go to the previous previous
  - **down arrow:**
    - to go to the next previous
  - **ctrl + a:**
    - jump to the beginning of the line
  - **ctrl + e:**
    - jump to the end of the line
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## Searching in file system

- **find:**
    - used to find file/directory from FS
    - e.g.
      - `find . -name "<criteria>"`
    - `-name`: search by file name
    - `-group`: search by group name
    - `-user`: search by user name
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## Dealing with text stream

### Regular Expression

- used to search by using special symbols/characters
- types
  - `\d`: represents a digit (0-9)
  - `^`: search from the beginning of the line
  - `$`: search in the end of the line
  - `.`: any character

- [a-z]: any character between a to z
  - +: one or more
  - \*: zero or more
  - ?: zero or one
  - {10}: the entity must occur 10 times consecutively
  - [.] or .: dot
  - **grep:**
    - used for searching within files/text sources
    - parameters
      - -w: search for whole word
      - -i: case insensitive
      - -n: print the line number along with the searched result
      - -c: print the count of lines
  - **egrep:**
  - **fgrep:**
  - **pgrep:**
  - **cut:**
    - used to cut the lines within a source by using a delimiter
    - e.g.
      - `cut -d ',' -f 1, 2, 3 <file name>`
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## Process management

- **ps:**
  - returns the processes list
  - displays information with
    - UID: user id
    - PID: process id
    - COMMAND
    - C: cpu usage
- **kill:**
  - used to kill a process by using PID
- **killall:**
- **pkill:**
  - used to kill a process by using PID
- **top:**
  - used to find the top processes (which are consuming more CPUs/Memory)
- **htop:**
  - similar to top but its more graphical
  - install using
    - `sudo apt-get update`

- `sudo apt-get install htop`

- **bg:**
  - **fg:**
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## Pipe

- **|:**
    - used to pass output of one command as an input to another command
    - e.g. `ps -ef | wc -l`
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## Redirection

- a way to redirect the values
  - standard file descriptor (fds)
    - stdout
      - by default it is mapped to console
    - stdin
      - by default it is mapped to keyboard
    - stderr
      - by default it is mapped to console
  - **>:**
    - output redirection
    - the output of a command can be captured in a file by redirecting the standard output
    - e.g.
      - `ls -l > files.txt`
      - `ps -ef > processes.txt`
  - **<:**
    - input redirection
    - used to get input from a file rather than from standard input (keyboard)
    -
  - **2>:**
    - error redirection
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## Booting Process

### POST

- Power On Self Test
- if the hardware components are working
  - cpu

- memory
- storage
- without RAM, a machine can **NOT** boot
- without storage, a machine can boot

## BIOS

- Basic Input Output Service (System)
- provides basis device drivers
- provides basic communication with
  - input devices
    - **keyboard**
    - **mouse**
    - lightpen
    - scanner
  - output devices
    - **monitor**
    - printer
- press F2/Delete/F10 to enter and configure the BIOS settings
- finds out the first bootable device
  - bootable device: which has MBR in first 512 bytes
  - MBR
    - 2 bytes
      - magic number
      - unique number that identifies the OS uniquely
      - every executable contains this magic number so that OS can execute the native application (which contains ASM code)
    - 64 bytes
      - partition table
      - details about the partition (FS)
    - 446 bytes
      - bootloader code
      - which loads the kernel
      - bootloaders
        - Linux
          - LiLo (Linux Loader)
          - GRUB (Grand Unified Bootloader)
        - Android
          - Universal bootloader (U-boot)
- Bootloader
  - stage 2:

- loads the FS in RO mode

- **Kernel**

- vmlinuz.x.x.x
- unarchives itself
- initialize the environment
- loads the FS in RW mode
- reserves some memory for itself
- starts basic services
  - network
  - volume
  - FS
  - WiFi
  - Bluetooth

- **SystemD**

- first user level process
- starts loading the file /sbin/init
- loads the user settings
- by loading the rc.config files

- **Lightdm**

- the desktop UI
- loads the login screen

## Runlevel

- which controls the booting behavior
- levels
  - **0**: halt (shutdown)
  - **1**: rescue mode (single user mode)
  - **2**: multi-user mode
  - **3**: multi-user mode + network
  - **4**: unused/reserved
  - **5**: graphical (GUI)
  - **6**: reboot
- commands
  - runlevel
    - used to display the current run level
  - systemctl
    - `sudo systemctl list-units --type target`
      - lists the targets
    - `sudo systemctl get-default`



- shows the current target
- update-grub
  - to update the grub settings