Lab3
File Systems (I) (Structure and File Types)

Comp311- Lab Linux

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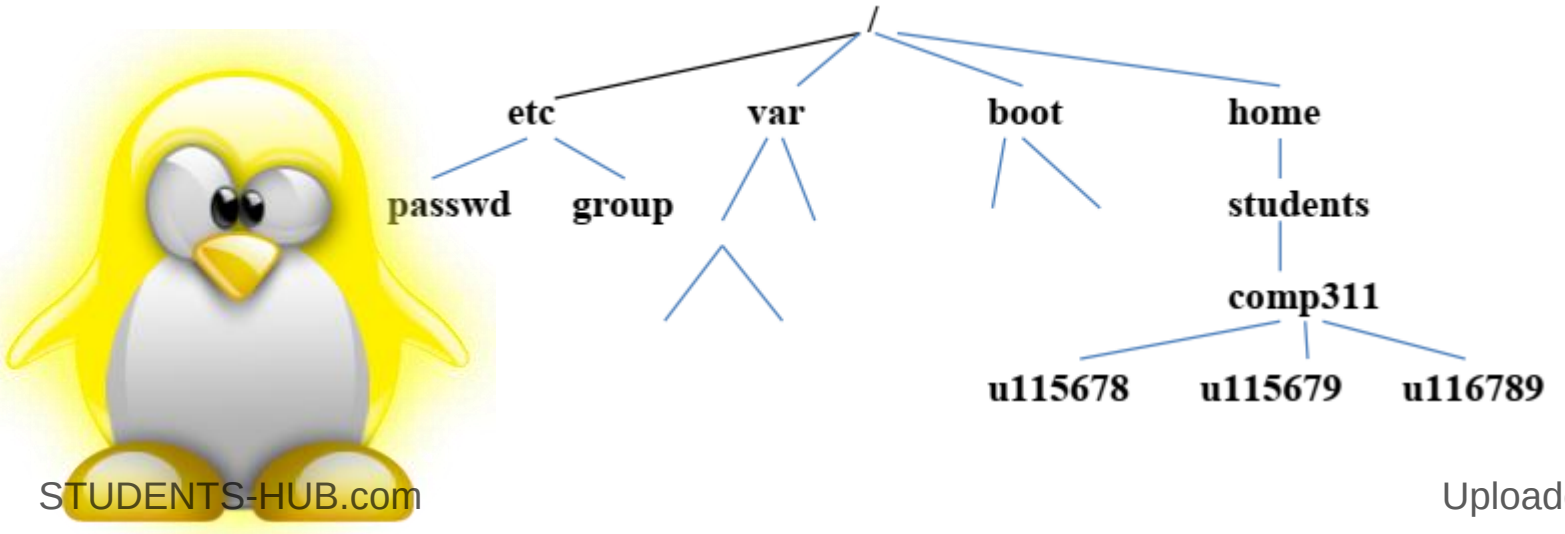
Objectives

After completing this lab, the student should be able to:

- Understand the structure of the Linux file system
- Build tree structures using **absolute and relative paths**
- Recognize and create the different main Linux file types



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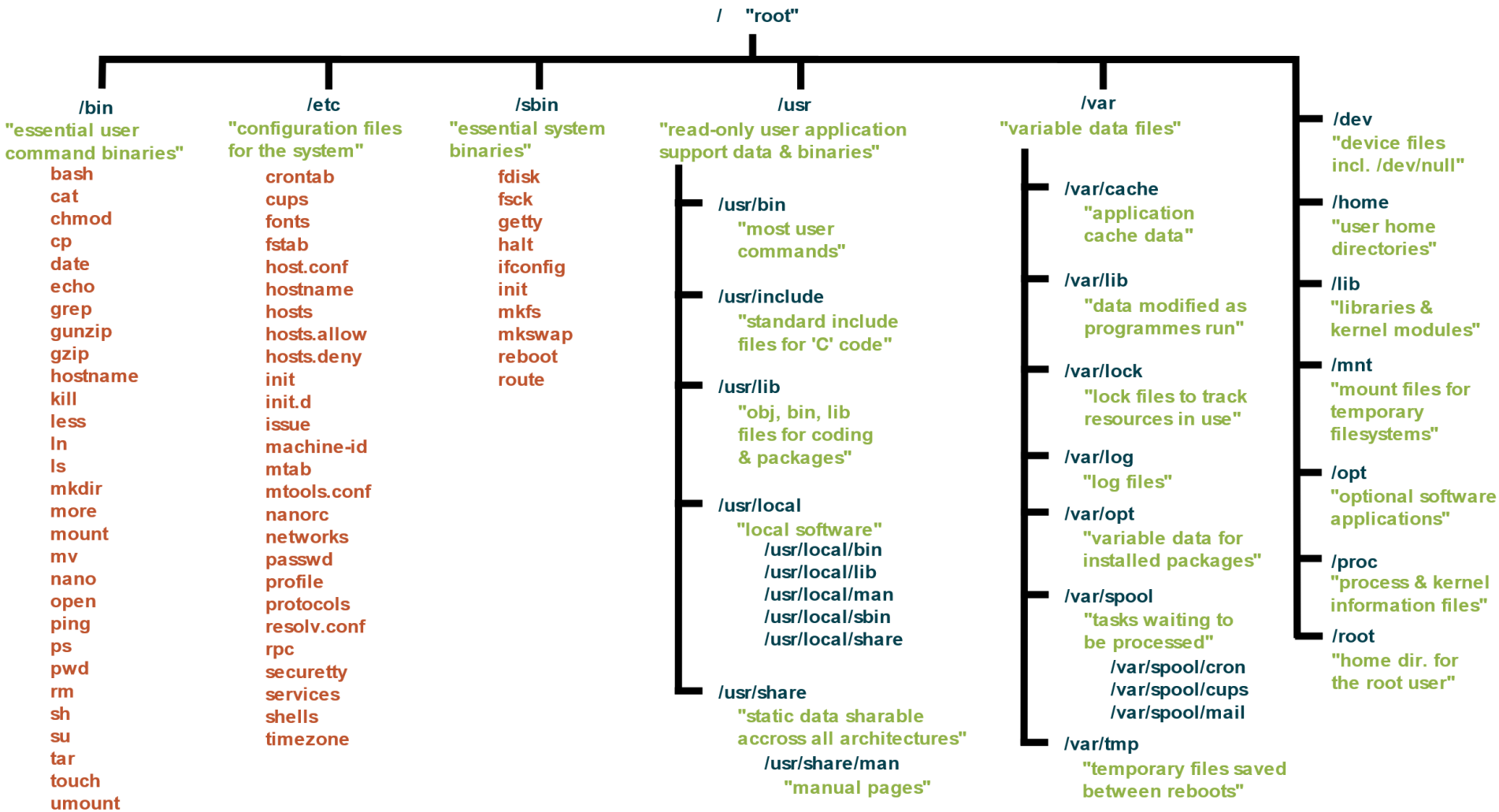
Linux File Systems Structure



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Linux File Systems

To display the file systems, use the command ***df*** (display file systems) as follows:

Run Command

1. ***df -h***

2. ***df -h T***

df -h (-h human readable format). (-T type ,ext2, ext4, nfs4, btrfs, xfs)

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Linux File Systems

Feature	EXT4	XFS	BTRFS
Architecture	Hashed B-tree	B+ tree	Extent based
Introduced	2006	1994	2009
Max volume size	1 Ebytes	8 Ebytes	16 Ebytes
Max file size	16 Tbytes	8 Ebytes	16 Ebytes
Max number of files	4 bi		
Max file name size	255		
Attributes	Y		
Transparent compression	N		
Transparent encryption	Y		
Copy-on-Write (COW)	N		
Snapshots	N		

Feature	FAT	FAT32	exFAT	NTFS	ReFS
Maximum volume size	4 GB	32 GB	128 PB	256 TB	4.7 ZB (zettabytes)
Maximum file size	4 GB	4 GB	16 EB (exabytes)	18 EB (exabytes)	18 EB (exabytes)
Maximum filename length	8.3 characters	255 characters	255 characters	255 characters	255 characters
Maximum cluster size	64 KB	32 KB	32 MB	2048 KB	64 KB
File compression	No	No	No	Yes	No
File encryption	No	No	No	Yes	No
Permissions	No	No	No	Yes	Yes

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Linux File Systems

To Manipulate directories under a file system, you can use the following commands:

	Command	Explanation
1	***mkdir newdir***	creates a new directory called newdir
2	***cd newdir***	changes your position to newdir
3	***rmdir newdir***	removes directory new directory only if newdir is empty
4	***rm –rf newdir***	removes non-empty or empty directory newdir
5	***pwd***	displays present working directory

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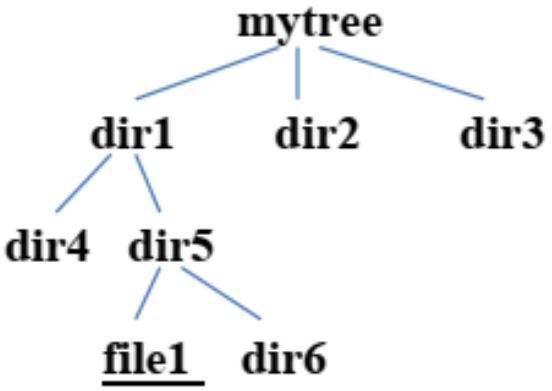
Practice.1:

Using the commands above, create the following tree under your **home directory**:



Direct thinking :

```
mkdir mytree
cd mytree
mkdir dir1 dir2 dir3
cd dir1
mkdir dir4 dir5
cd dir5
mkdir dir6
touch file1
```

To display your tree use the command:
ls –R mytree

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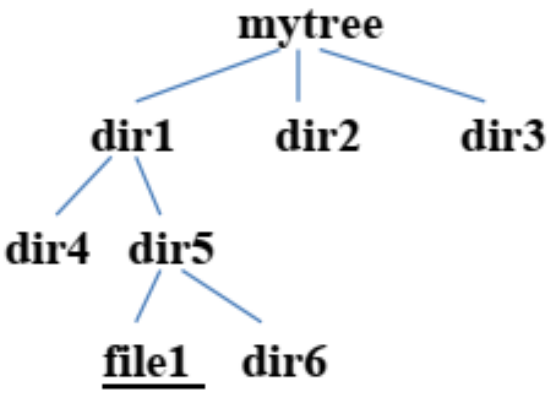
Practice.2-1:

A. Delete tree structure you created at your home directory

rm -rf mytree? why

B. Rebuild the same tree at you home directory.



mkdir mytree

mkdir mytree/dir1 mytree/dir2 mytree/dir3

mkdir mytree/dir1/dir5

mkdir mytree/dir1/dir5/dir6

….

rm -rf mytree

Try:

mkdir mytree/dir1 mytree/dir2 mytree/dir3

mkdir -p mytree/dir1 mytree/dir2 mytree/dir3

mkdir –p mytree/{dir2,dir3,dir1/{dir4,dir5/dir6}};touch mytree/dir1/dir5/file1

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Practice.2-2:

A. Delete tree structure you created at your home directory

rm -rf mytree

B. Construct The previous tree (mytree) **using absolute path method in one line** ?

mkdir –p mytree/{dir2,dir3,dir1/{dir4,dir5/dir6}};touch mytree/dir1/dir5/file1

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Absolute and Relative Paths

Any Linux file may be referenced by either its **absolute path name or relative path** name. Each file **has one and only one absolute path name while it may have an infinite number of relative names**.

The absolute path name (**from root, /, to location of file**)**for file1** in the previous tree is:

/home/students/comp311/username/mytree/dir1/dir5/file1

While it has several relative names such as:
./mytree/dir1/dir5/file1
./mytree/../mytree/dir1/dir4/../dir5/file1
and so forth. Notice that (**.**) stands for current directory while (**..**) stands for previous (parent) directory.

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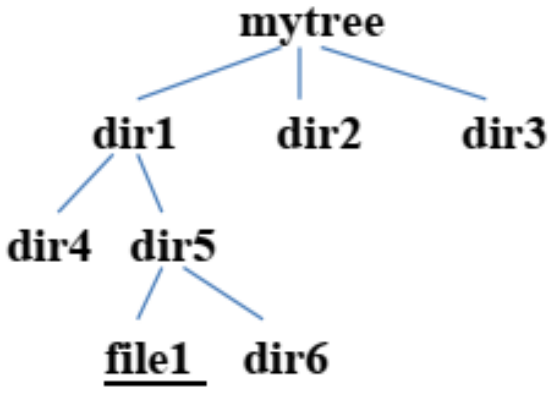
Practice.3:

A. Remove the sub tree ***mytree*** created in the previous section (***rm –rf mytree***)
Now try creating the whole tree **again using relative paths** from your home directory (i.e. you are **not allowed** to use the **cd** command to create any parts of the tree)




```
mkdir mytree
mkdir mytree/dir1
mkdir mytree/dir2
mkdir mytree/dir3

mkdir mytree/dir1/dir4
mkdir mytree/dir1/dir5
mkdir mytree/dir1/dir5/dir6
touch mytree/dir1/dir5/dir6/file1
```

B. Construct The previous tree (mytree) **using relative path method in one line** ?

mkdir –p mytree/dir1/../dir2/../dir3/../dir1/dir4/../dir5/dir6

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What is the difference between ?

ls /mytree/dir1
ls mytree/dir1
ls ./mytree/dir1

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ls /mytree: from root

ls mytree

ls ./mytree :from current position

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So far, we have mentioned two types of Linux files as follows:

1- **Regular files** which include **scripts**, **binaries**, as well as **text files**. These files contain data and are identified by any empty first slot when we list them using the ***ls –al filename*** command. These are created using the ***vi*** editor.

2- **Directories** which are simply containers that **include the mappings** between filenames and subdirectory names and their unique inode (index) number in the file system. These are identified by the letter ***d*** in the first slot when we list them using the **ls –al dirname** command. These are created using the **mkdir** command.

drwxrwxr-x 2 mnjoum mnjoum 4096 Sep 23 18:38 dir4

-rw-rw-r-- 1 mnjoum mnjoum 0 Sep 23 19:14 file1

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The third type of Linux files are the special (device) :

3. **The third type** of Linux files are the **special (device)** files which are usually located under the ***/dev*** directory. There are two types of device files:

1- **Character device files**: which are used to read and write from/to devices one character at a time (e.g. keyboard device files). These are identified with the character ***c*** when we list them with the ls –al command.

2- **Block device files**: which are used to read and write from/to devices one block at a time (e.g. disk device files).). These are identified with the character **b** when we list them with the ls –al command.

```
brw-rw----   1 root disk      8,   1 Sep 23 16:11 sda1

crw--w----   1 root tty       4,  19 Sep 23 16:11 tty19
```

Run the command ls –al on the /dev directory. List three character device files and three block device files.?

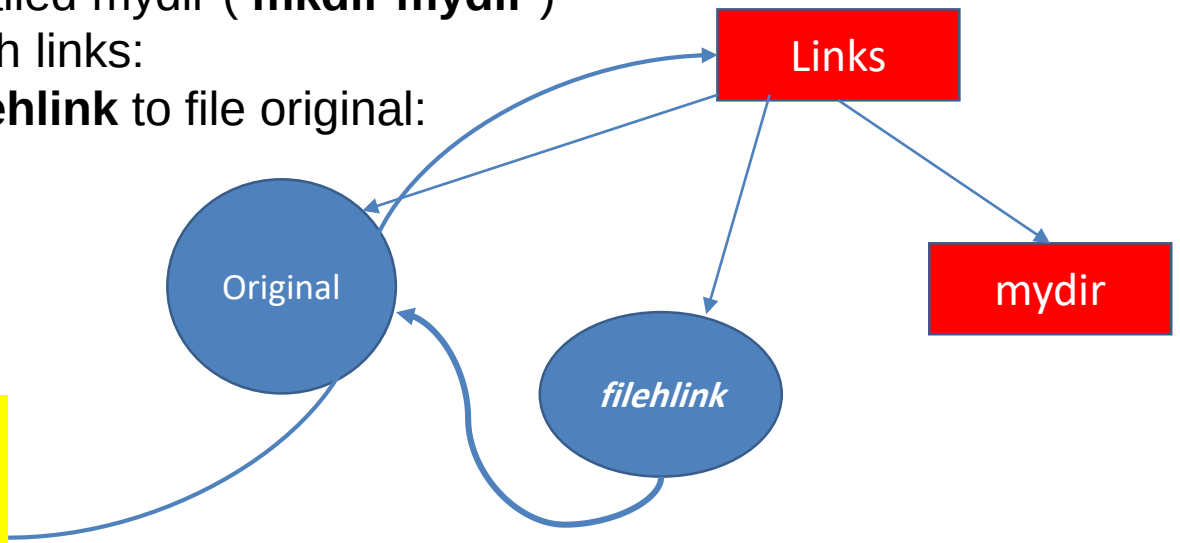
The fourth type of Linux files are the links:

The original links in Linux are called the **hard links** and are created using the command
ln.

Practice:

1. Create a directory to try some links (**mkdir links; cd links**)
Create a file called original and (***vi original***) put the phrase "this is original" inside then save and quit

2. Now create a directory called mydir (**mkdir mydir**)
Let us now start working with links:
Create a hard link called **filehlink** to file original:



From inside directory links run command
`ln original filehlink`

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The fourth type of Linux files are the links:

List the files in your directory with ***ls –ali*** (the i option displays the inode numbers) Notice that all the properties of file original and link filehlink (**except the name**) are exactly the same **(even the inode number**). Hard links basically give a new name to the same inode number.

19531008 -rw-rw-r-- 2 mnjoum mnjoum **26** Sep 23 19:59 filehlink

19531008 -rw-rw-r-- 2 mnjoum mnjoum **26** Sep 23 19:59 orignal

Hard links have two limitations:

1- Not allowed on directories

Try the command:

ln mydir dirhlink ***What was the result?***

hard link not allowed for directory

2- Not allowed across different devices (file systems)

Try the command:

ln /etc/passwd passwdhlink ***What was the result?***

Invalid cross-device link

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symbolic (soft)

Those limitations are solved using a different type of links called symbolic (soft) links.

To create a symbolic link simply use the option (-s) with the ***ln*** command.

Try the following commands and see what happens:

rm filehlink

ln -s original fileslink

ls –ali (what are the differences between original and fileslink properties?)

```
mnjoum@ubuntu:~/links$ ls -ali
total 76
19531017 drwxr-xr-x  5 mnjoum mnjoum  4096 Sep 23 20:38 .
19136520 drwx------ 72 mnjoum mnjoum 32768 Sep 23 19:59 ..
19531018 drwxr-xr-x  2 mnjoum mnjoum  4096 Feb 28  2018 dir1
19531019 drwxr-xr-x  2 mnjoum mnjoum  4096 Feb 28  2018 dir2
19531007 lrwxrwxrwx  1 mnjoum mnjoum     5 Sep 23 20:26 dirhlink -> mydir
19531010 lrwxrwxrwx  1 mnjoum mnjoum     7 Sep 23 20:38 fileslink -> orignal
21890415 drwxrwxr-x  2 mnjoum mnjoum  4096 Sep 23 20:00 mydir
19531008 -rw-rw-r--  1 mnjoum mnjoum    26 Sep 23 19:59 orignal
19531009 lrwxrwxrwx  1 mnjoum mnjoum    11 Sep 23 20:28 passwdhlink -> /etc/passwd
```


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Practice.4:

ls –ali (what are the differences between original and fileslink properties?)

_____.

ln –s mydir dirslink (what happened now?)

_____.

ln –s /etc/passwd passwdslink (what happened now?)

_____.

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1. **What will be happen with hard link if we delete the original file ?**

2. What will be happen if we delete soft (symbolic) link ?

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1. What will be happen with hard link if we delete the original file ?

Hard link : Original deleted, link not affected, still can edit it (as a copy of original file)

2. What will be happen if we delete soft (symbolic) link ?

Soft link : Original deleted, link destroyed, can edit it the original (empty file)

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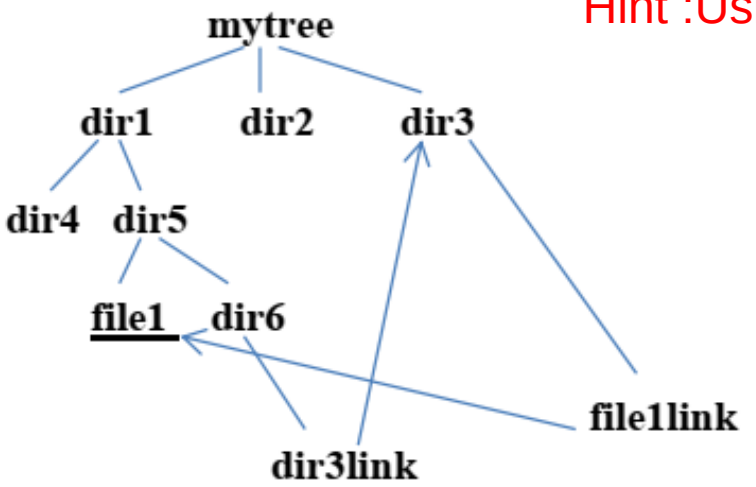
Now go back to the tree you created earlier (***mytree***) and add the links shown below:

Hint :Using relative path methods!!



What commands did you use:

1. cd mytree/dir3

   ln ./../dir1/dir5/file1 file1link

2. cd mytree/dir1/dir5/dir6

   ln -s ./../../../dir3 dir3link

Although there are few more types of Linux files such as pipe files or socket files. They are rarely used or seen by users.

Another solution : ln -srf mytree/dir1/dir5/file1 mytree/dir3

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Thank You Guys

Published By: Murad Njoum