ULI101

Week 08

Week Overview

- File system links
- Hard and symbolic links
- Process management
- Storage quota information

What is a file system Link?

A link is a pointer to a file.

- This pointer associates a file name with a number called an *i-node* number
- An *i-node* is the control structure for a file (on a UNIX/Linux file system)
- If two file names have the same *i-node* number, they are links to the same file

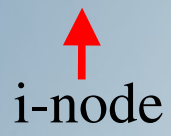
What is a file system Link?

- Use the command "**ls -i**" to print i-node number of each file:

```
[ray@localhost week8]$ ls -i
  32764 lab3a.html    37745 lab3b.html
  37740 lab3.zip
```

- Use the command "**ls -il**" for long listing

```
[ray@localhost week8]$ ls -il
total 40
  32764 -rw-r--r--  1 ray  ray 1097 Sep 13 08:53 lab3a.html
  37745 -rw-r--r--  1 ray  ray 6582 Sep 13 08:53 lab3b.html
  37740 -rw-rw-r--  1 ray  ray 6218 Sep 14 00:05 lab3.zip
```



What is a file system Link?

There are two kinds of links:

1. Hard Links
2. Soft or Symbolic Links

Hard Links

- Hard link is a reference to the physical data on a file system
- More than one hard link can be associated with the same physical data
- Hard links can only refer to data that exists on the ***same*** file system
- Only the root user can create hard links to a directory
- When a file has more than one link, you can remove any one link and still be able to access the file through the remaining links.

Hard Links

Example:

- Assume you used “vi” to create a new file, you create the first hard link (vi myfile)
- To Create the 2nd, 3rd and etc. hard links, use the command:
  - `ln myfile` ***`link-name`***

Display Hard Links info

- Create a new file called “myfile”
- Run the command “ls -il” to display the ***i-node number*** and ***link counter***

```
38753 -rw-rw-r--  1 uli  uli    29 Oct 29 08:47 myfile
  ^               ^
  |-- inode #     |-- link counter (one link)
```

Display Hard Link Info

- Create a 2nd link to the same data:

  ln myfile mylink

- Run the command “ls -il”:

```
38753 -rw-rw-r-- 2 uli  uli    29 Oct 29 08:47 myfile
38753 -rw-rw-r-- 2 uli  uli    29 Oct 29 08:47 mylink
 ^               ^
 |-- inode #     |--link counter (2 links)
```

Add the 3rd Link

- Create a 3rd link to the same data:

  ln myfile newlink

- Run the command “ls -il”:

```
38753 -rw-rw-r-- 3 uli  uli    29 Oct 29 08:47 myfile
38753 -rw-rw-r-- 3 uli  uli    29 Oct 29 08:47 mylink
38753 -rw-rw-r-- 3 uli  uli    29 Oct 29 08:47 newlink
 ^               ^
 |-- inode #     |--link counter (3 links)
```

Symbolic Links

Also Known As (a.k.a.): Soft links or Symlinks

- A Symbolic Link is an indirect pointer to a file – a pointer ***to*** the hard link ***to*** the file
- You can create a symbolic link to a directory
- A symbolic link can point to a file on a different file system
- A symbolic link can point to a nonexistent file (referred to as a “broken link”)

Symbolic Links

- To create a symbolic link to the file “myfile”, use

  ln -s myfile symlink **or**

  ln --symbolic myfile symlink

```
[uli@seneca courses] ls -li myfile
44418 -rw-rw-r-- 1 uli uli   49 Oct 29 14:33 myfile

[uli@seneca courses] ln -s myfile symlink
[uli@seneca courses] ls -li myfile symlink
44418 -rw-rw-r-- 1 uli uli  49 Oct 29 14:33 myfile
44410 lrwxrwxrwx 1 uli uli   6 Oct 29 14:33 symlink -> myfile
```

Different i-node

File type: (symbolic link)

Link counter: (1 link)

Properties of Symbolic Links

- The i-node number is different from the pointed to file
- The link counter of the new symbolic link file is “1”
- Symbolic link file does not affect the link counter of the pointed to file
- The type field of symblic file contains the letter “l”
- The symbolic link file and the pointed to file have different status information (e.g. file size, last modification time etc.)

Create Symbolic Link Directory

- The syntax is the same as linking to a file
  ln -s target_directory link_directory
  ln --symbolic target_directory link_directory

```
[uli@seneca week8]$ ls -li
38766 drwxrwxr-x 7 uli uli  168 Oct 29 13:32 courses

[uli@seneca week8]$ ln courses mydir
ln: `courses': hard link not allowed for directory
[uli@seneca week8]$ ln -s courses mydir
[uli@seneca week8]$ ls -li
38766 drwxrwxr-x 7 uli uli 168 Oct 29 13:32 courses
44417 lrwxrwxrwx 1 uli uli   7 Oct 29 15:41 mydir -> courses
```

Directory Listing

- To display the contents in a directory, we usually use the command “ls -l directory_name”
- Compare the following two commands

```
[uli@seneca week8]$ ls -l mydir
lrwxrwxrwx  1 uli uli     7 Oct 29 15:41 mydir -> courses

[uli@seneca week8]$ ls -l courses
drwxrwxr-x  2 uli uli    72 Oct 29 11:15 ica101
drwxrwxr-x  2 uli uli    72 Oct 29 11:16 ios110
drwxrwxr-x  2 uli uli   120 Oct 29 11:20 to_do
drwxrwxr-x  2 uli uli    72 Oct 29 11:14 uli101
```

Delete link to a directory

To delete a link to a directory, simply use the “rm” command:

```
[uli@seneca week8]$ ls -l
 drwxrwxr-x 7 uli uli 168 Oct 29 13:32 courses
 lrwxrwxrwx 1 uli uli   7 Oct 29 15:41 mydir ->
  courses

[uli@seneca week8]$ rm mydir
[uli@seneca week8]$ ls -l
 drwxrwxr-x 7 uli uli 168 Oct 29 13:32 courses
```

Properties of Symbolic Link Directory

- The Symbolic link to a directory has a file type of “l” (the first letter of the permission field).
- The permissions on the link are set to “rwx” for all.
- chmod on the link applies to the actual directory (or file), the permissions on the link stay the same
- Can point to a non-existent directory

UNIX processes

- Almost everything that is “running” on a UNIX system is referred to as a process
- Each process has an owner
- Each process has a unique ID (PID)
- Processes in UNIX can run in:
  - Foreground
  - Background

Process structure

- UNIX processes are hierarchical
- This structure has a root, parents and children
- Creation of a new process is called forking or spawning
- Parent can fork a child and children can fork their own children
- Processes keep their PID for their entire life
- Usually parent sleeps when a child is executing its task
  - The exception is when the child process is run in the background

Process identification

- ps (process status) command displays snapshot information about processes
- By default, the ps command displays information only about current terminal (ps -U username shows all)
- The top command provides a continuous update including resource usage

Foreground and background

- Foreground processing:
  - Is the default
  - Takes away the command line until processing is finished
- Background processing:
  - Is invoked by putting the ampersand (&) operator at the end of the command line
  - User gets the command line back immediately
- Both foreground and background processes can be executed on one command line
- Background processes run concurrently (at the same time)

Process suspending

- A foreground job can be suspended (temporarily stopped) by pressing Ctrl+Z
- Stopped jobs can be restarted by using the fg command
  Syntax:

```
        fg
OR      fg job_number (1,2...)
OR      fg PID
```

  - fg without id/job will bring the last background process to foreground
  - The jobs command will show a list of background/suspended processes

Process restarting

- Restarting in foreground:

  fg PID OR

  fg job_number
- Restarting in background:

  bg PID OR

  bg job_number

Terminating processes

- Foreground processes can be terminated by using Ctrl+C or can be killed
- Background processes have to be killed unless brought to foreground – then Ctrl+C will work

kill command

- Terminates a process
- One or more processes can be terminated at once
- Regular users can only kill processes they own
- Syntax:

  kill PID
- In some cases may be ignored by the shell – use kill –9 PID instead
- kill –9 0 will terminate all background processes
- pkill command can kill processes based on the program name, for example: pkill firefox

Storage Quotas

- All file systems have finite capacity
  - Try the du and df commands to find out more
- Most regular user accounts have a quota
  - A quota limits the amount of disk space you can consume
  - This ensures that a single user cannot interfere with the file system use for others
- The amount of quota and disk usage can be obtained using the quota command
- If you want more disk space…
  - Temporarily – use the /tmp directory
  - Permanently – ask the administrator