Hard & Symbolic Links

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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
```

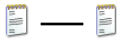
i-node

What is a file system Link?

There are two kinds of links:

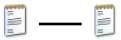
1. Hard Links
2. Soft or Symbolic Links

Hard Links



- Hard link is a reference to the physical data on a file system
- All regular files are actually hard links
- More than one name can be associated with the same physical data
- Hard links can only refer to data that exists on the ***same*** file system
- You can **not** create hard link to a directory

Hard Links



Example:

- Assume you used an editor to create a new file, you've just created the first hard link
- 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)
```

Removing a Hard Link

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.

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
  - Not so for hard links
- A symbolic link can point to a file on a different file system
  - Not so for hard links
- 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 normally 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.
- The chmod command applied on the link applies to the actual directory (or file), the permissions on the link stay the same
- Can point to a nonexistent directory

Drawbacks of Symbolic Links

- If the original file is moved to a different location, it can no longer be accessed via the symbolic link (dangling link)
- Extra space on disk and extra inode to store the link file (minimal)
- Extra time required for access to the original file: the link file has to be read first, then path followed to target file (minimal)