CSCI 330

UNIX File Permissions

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UNIX File Permissions - Outline

UNIX File Permissions

- All access to directories and files is controlled
- UNIX uses DAC model
  - discretionary access control
  - each directory/file has owner
  - owner has discretion of access control details
- Access control includes
  - read, write: to protect information
  - execute: to protect state of system
- Exception: Super user (root user)

User Terminology

- User
  - Anyone who has account on the system
  - Originally listed in `/etc/passwd`, now in `/etc/shadow`
  - protected via password
  - internally recognized via an integer called the user id
- Group
  - users are organized into groups
  - listed `/etc/group` (and `/etc/gshadow`)
  - a user can belong to multiple groups
- Super user, `root`
  - has user id 0
  - responsible for system administration

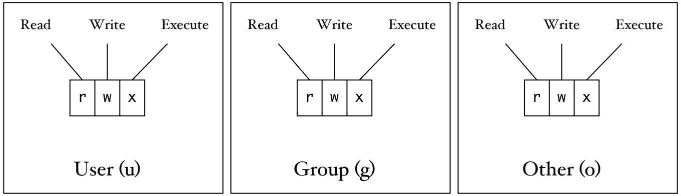
File/Directory access

- Every file/directory has an owner, usually the user who created it.
- The owner sets access permissions
  - access modes: read (`r`), write (`w`), execute (`x`)
  - accessor category: user (owner (`u`)), group (`g`), others (`o`)
- Change ownership via: `chown`

Access Permission Modes

	For File	**For Directory**
`r` (read)	View file contents (open, read)	List directory contents.
`w` (write)	Change file contents	Add/remove files from the directory.
`x` (execute)	Run file as executable.	Able to enter the directory and access files inside. (search)
-	Permission denied.	Permission denied.

Categories of Users



Three categories of user, three types of access for each.

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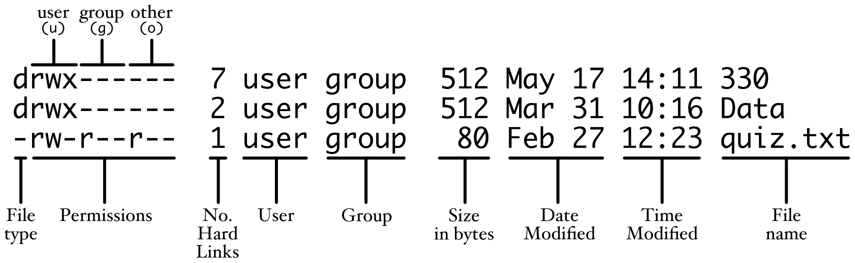
Checking Permissions

To check the permissions of an existing file or an existing directory, use the command: `ls -l`



```
drwx------  7 user group  512 May 17 14:11 330
drwx------  2 user group  512 Mar 31 10:16 Data
-rw-r--r--  1 user group   80 Feb 27 12:23 quiz.txt
```

The permissions of each file are shown with `ls -l`

Change Permissions with chmod

```
% chmod [-options] mode file
```

- mode – octal or symbolic mode for file
- file – name of file to change mode for

Option	Effect
-R	recursively apply to contents of directory

Changing Permissions: Symbolic Mode

- For whom?
  - `u` for user who owns the file
  - `g` for group
  - `o` for others
  - `a` or `ugo` for all three
- Do what?
  - `+` for add
  - `-` for remove
  - `=` for assign/set to
- For what type(s) of access?
  - `r` for read
  - `w` for write
  - `x` for execute/search

Examples: Symbolic Mode

```
% chmod u-w file.txt
% chmod u+w file.txt
% chmod u+x script.sh

% chmod g-w file.txt
% chmod o-rw file.txt

% chmod ug=rwx play.cc
% chmod a+wx other.html

% chmod u+x,go=r script.sh
```

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Changing Permissions: Octal Mode

```
 u   g   o  values --> r=4 w=2 x=1
rwx rwx rwx
111 111 111
421 421 421 value for rwx, or 0 if -
  7   7   7 sum of above 3 values
  yields 777

r-- -wx rw-
100 011 110 1 for rwx, 0 for -
400 021 420 value for rwx or 0 if -
  4   3   6 sum of above 3 values
  yield 436
```

Changing Permissions: Octal Mode

Step	Perform	
1	List the desired setting	`rwx|r-x|r-x`
2	Assign binary; 1 for access 0 for none	`111|101|101`
3	List octal values for corresponding 1's	`421|401|401`
4	Add up the numbers for each of u,g,o	`7	5	5`
5	Write up the command	`chmod 755 sort.c`

```
% ls -l sort.c
```

```
-rwxr-xr-x 1 ege  csci 80 Feb 27 12:23 sort.c
```

Goal: set mode of file `myfile`

- Read, write, and execute permissions to owner
- Read and execute permissions to group
- Execute permission to others

We want:

```
 u   g   o
rwx r-x --x
111 101 001 bits
421 401 001 values
  7   5   1 sum
```

Using Symbolic Mode: `chmod u=rwx,g=rx,o=x myfile`

Using Octal Mode: `chmod 751 myfile`

Special Permissions

- The regular file permissions (`rwx`) are used to assign security to files and directories
- Three additional special permissions can be optionally used on files and directories
    - Set User ID (SUID)
    - Set Group ID (SGID)
    - Sticky bit

Special Permissions: SUID

- SUID used for executable files
  - makes executable run with privileges of file owner, rather than the invoker
  - Example:
    - `passwd` command and file `/usr/bin/passwd`

```
-rwsr-xr-x  1  root root 42776 2019-04-04 00:50 passwd
```

    - This allows regular user access to system files while changing password.

Special Permissions: SGID

- logic is similar to SUID bit used for executable files
- runs program with group permission of file, rather than group of invoker
- Example:
  - if a file is owned by the system group and also has the SGID bit set, then if file is executed it runs with system group privileges

Special Permissions: Sticky Bit

- Different uses on different systems, not clearly defined
- For executable files:
  - Executable is kept in memory even after it ended (no longer used, since modern virtual memory methods are more advanced)
- For directories:
  - File can only be deleted by the user that created it

Special Permissions: display

`ls -l` command does not have a section for special permission bits

However, since special permissions all required "execute", they mask the execute permission when displayed using the `ls -l` command.

```
r w x  r w x  r w x <- normal
    |      |      |
r w s  r w s  r w t <- special
    ^      ^      ^
 suid   guid sticky
```

Setting Special Permissions

bit values (in order):

suid	sgid	sticky	r	w	x	r	w	x	r	w	x
4	2	1	4	2	1	4	2	1	4	2	1

as octal:

special	user	group	other
7	7	7	7

Use the `chmod` command with octal mode:

```
% chmod 7777 filename
```

Setting Special Permissions

`chmod` with symbolic notation:

`u+s`	add SUID
`u-s`	remove SUID
`g+s`	add SGID
`g-s`	remove SGID
`+s`	add SUID and SGID
`+t`	set sticky bit

File mode creation mask

- `umask` (user mask)
  - governs default permission for files and directories
  - sequence of 9 bits: 3 times 3 bits of `rwx`
  - default: `000 010 010` binary (`022` octal)
- In octal form its bits are removed from:
  - for a file: `110 110 110` (`666`)
  - for a directory: `111 111 111` (`777`)
- Permission for new
- file: `110 100 100` (`644`)
- directory: `111 101 101` (`755`)

User Mask values

umask	Directory default: `777`	File default: `666`
`000`	`777 rwxrwxrwx`	`666 rw-rw-rw-`
`111`	`666 rw-rw-rw-`	`666 rw-rw-rw-`
`222`	`555 r-xr-xr-x`	`444 r--r--r--`
`333`	`444 r--r--r--`	`444 r--r--r--`
`444`	`333 -wx-wx-wx`	`222 -w--w--w-`
`555`	`222 -w--w--w-`	`222 -w--w--w-`
`666`	`111 --x--x--x`	`000 ---------`
`777`	`000 ---------`	`000 ---------`

Change the permission default

- Command to display: `umask`
  - uses a leading zero, i.e. `0022`
- command to change: umask
  - tolerates leading zero

```
% umask -S u=rwx,g=rx,o=rx
% umask 0077
% umask a-r
```

Summary

r, w, x

- and extra bits (s,t)

user (self, owner), group, others

file mode creation mask: umask