LECTURE NOTES IN CIS300

YUZHE TANG

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SECTION 1: BASH

REFERENCES

- "Basic UNIX commands" [link]
- "Bash Guide for Beginners" [link]
- "Advanced Bash-Scripting Guide" [link]

GETTING STARTED

Access Shell terminal in your computer

- Option 1: Web terminal
  - [http://www.webminal.org/terminal/]
- Option 2: Setting up Ubuntu through VirtualBox
  - TA will talk about this.

LECTURE 2: FILES & DIRECTORIES

DIRECTORIES

- List files and directories: `ls`
  - `ls ~`, `ls .`, `ls`
  - `ls /`
  - `ls -al`
- Enter a directory: `cd`
  - `cd`, `cd ~`, `cd ..`
  - `cd /`
- Print the current pathname: `pwd`
- Create a directory: `mkdir`
  - `mkdir dir_a`

BASIC FILE MANAGEMENT

- Create a file: `touch`
  - `touch file_a`
- Move a file (change file name): `mv`
  - `mv file_a file_b`
- Copy a file: `cp`
  - `cp file_a file_b`
- Remove a file: `rm`
  - `rm file_a`

BASIC FILE MANAGEMENT (2)

- Show the content of a file: `cat`, `more`
  - `cat file_a`
  - `more file_a`: use `q` to quit, `/` to search
  - Write text to a file: `echo >>`
    - `echo "Alice Bob" >> file_a`
    - `echo "Alice" >> file_b`,
      `echo "Alice" >> file_c`
- Show the count of lines/words/chars a file: `wc`
  - `wc file_a`
- Show difference between files: `diff`
  - `diff file_a file_b`

EXERCISE 2.1

1. Run command `ls -a /`. Copy and paste (C&P) the printout on BB.
2. Run command `cat file_b`. C&P printout on BB.
3. Create a directory `dir_b` under `dir_a` and enter it. C&P the commands on BB.
4. Create a text file named `file_d.txt` and put there the following string: `Charlie is a student`. Run `cat file_d.txt`.
   - C&P the list of commands and their printout on BB

LECTURE 3: FILE PERMISSION

REFERENCES

- Understanding Linux file permissions [link]

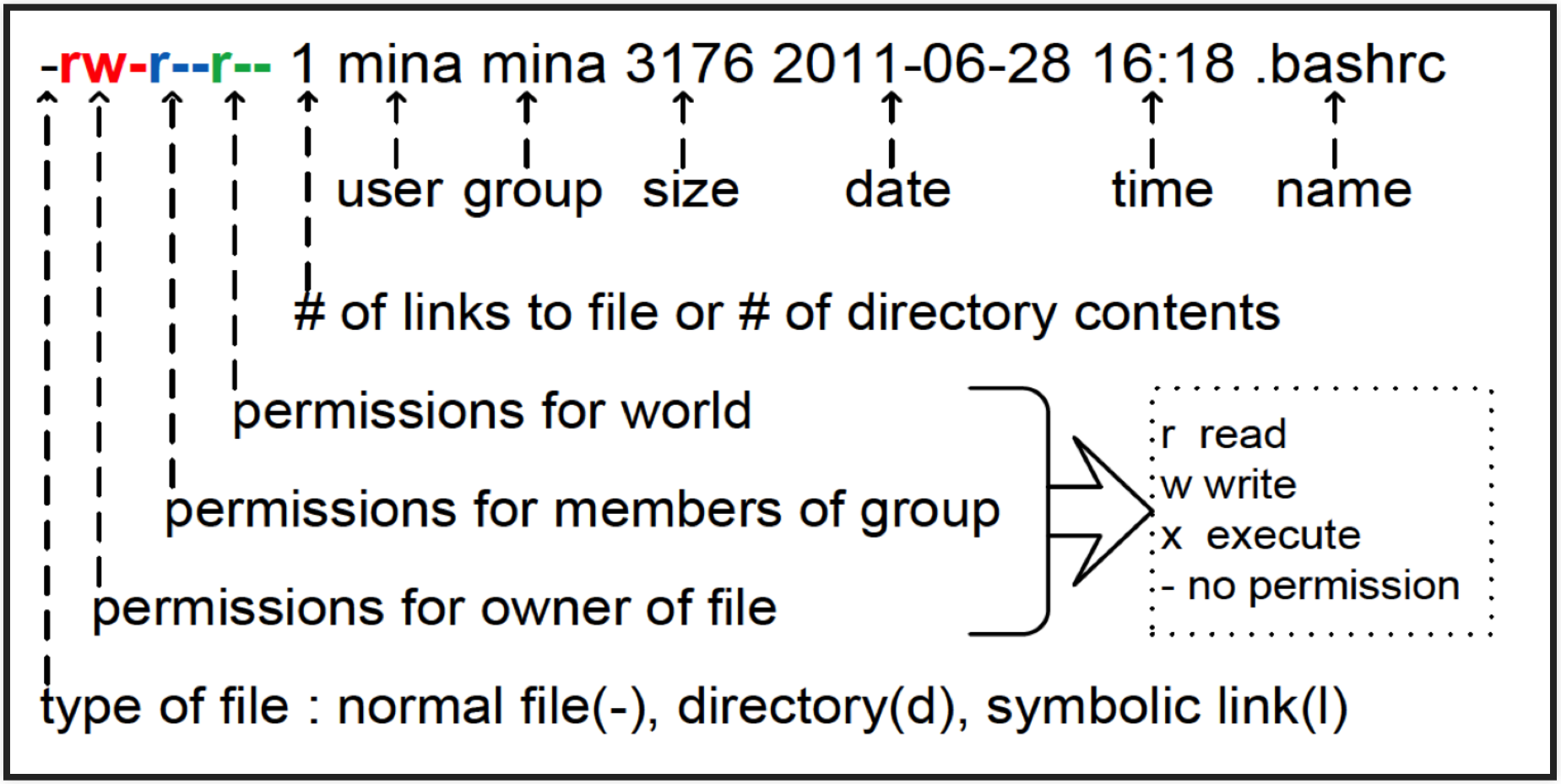
BASIC CONCEPT

- file permission: access right, or file mode
  - permission controls the ability of a *user* to take *actions* on a *file*
  - user: owner, group, all users
    - group: group of users and files.
  - type: read, write, execute

VIEWING PERMISSION

`ls -l`

- owner and group
- permissions
  - users: owner (`u`), group (`g`), others (`o`), all users (`a`)
  - type: read (`r`), write (`w`), execute (`x`)


-rw-r--r-- 1 mina mina 3176 2011-06-28 16:18 .bashrc
user
group
size
date
time
name
# of links to file or # of directory contents
permissions for world
permissions for members of group
permissions for owner of file
r read
w write
x execute
- no permission
type of file : normal file(-), directory(d), symbolic link(l)

ls -al

CHANGING PERMISSION

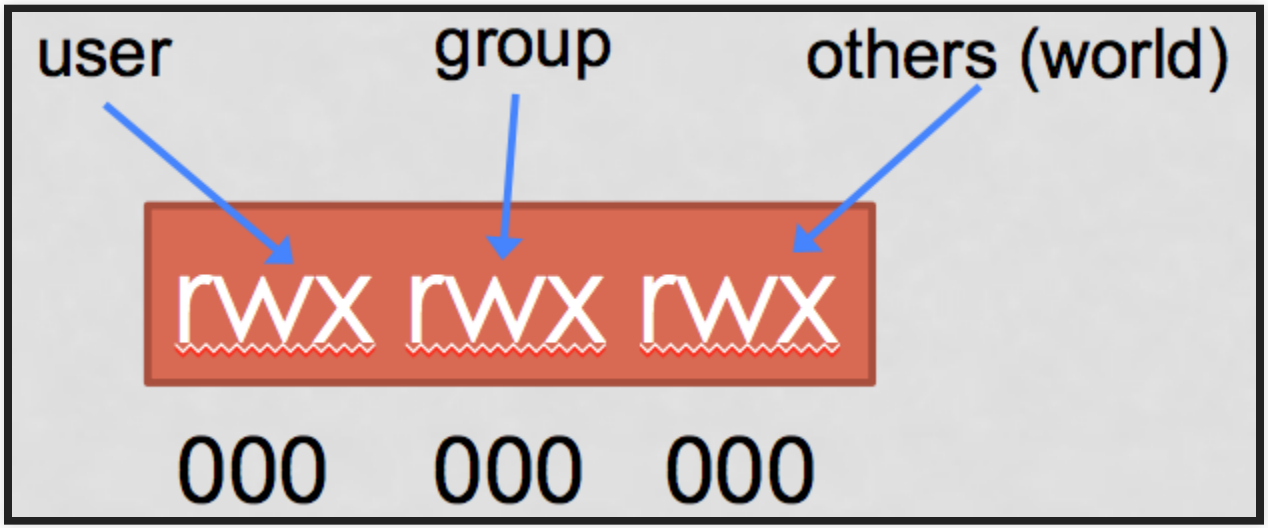
- `chmod`: change mode
  - add +:
    - `chmod a+wx file_a`: add write/execute permission to all users
    - `chmod g+r file_a`: add read permission to group users
  - assign/copy =:
    - `chmod g=rw file_a`: assign read/write permission to group
    - `chmod g=u file_a`: copy owner permission to group permission

CHANGING PERMISSION (2)

Options	Definitions
u	Owner
g	Group
o	Other
a	All (same as ugo)
x	Execute
w	Write
r	Read
+	Add permission
-	Remove permission
=	Set permission

CHANGING PERMISSION: NUMERIC MODE (3)

- `chmod 777 file_a;chmod a+rwx file_a`
  - `chmod 666 file_a;chmod a=rw file_a`
  - `chmod 000 file_a;chmod a-rwx file_a`



CHANGE OWNERSHIP

- `chown owner:group filename`
  - `chown user1:staff file_a`

EXERCISE 3.1

1. Run command `chmod o-r file_a; cat file_a`. C&P the printout on BB.
2. Design the command to make a file read-only to group. C&P your command on BB.
3. Design the command to make a file read-only to all users. C&P your command on BB.
4. Convert the following two commands to numeric mode: `chmod a-rwx file_a; chmod o+x file_a`. C&P your command on BB.

LECTURE 4: TEXT EDITING

- `gedit`: text editor with GUI
  - `gedit filename &`
- `vim`: text editor in terminal
- other editors: `emacs`, etc.

VIM

- basic movement: `h`,`j`,`k`,`l`
  - word movement: `w`,`e`,`b`
    - `w`ord, `e`nd, `b`egin
  - number powered movement: `5w`
- find character in current line: `f`
  - `fq`: find char `q` in current line
  - `2fn`: find the second char `n` in current line
  - find word under cursor: `*` (next) and # (previous)
  - go to matching parentheses: `%`

VIM (2)

- begin and end of line: `0` and `$`
- go to line: `g`
  - first line: `gg`
  - last line: `G`
  - 10th line: `10gg`
- search: `/keyword` with `n` and `N`

VIM (3)

- modes: normal and insert
- from normal to insert: `i`, `o`, `R`
  - backward: `esc`
- editing in normal mode
  - copy/yank : `v+y`
  - and paste: `p`
  - cut: `v+x`
  - delete: `v+d`
  - undo/redo: `u`,`R`
- save/exit a file
  - write: `:w`
  - quit: `:q`

DEMO/PRACTICE

- Install vim on your VM: `sudo apt-get install vim`
- Or use online Vim: http://www.openvim.com/

EXERCISE

1. Write down the action sequence that searches String `Alice` in a file opened in vim
2. Open `file_a.txt` using vim. Insert your name in the file, save it, and close the file. C&P the actions you used.
3. What do the following action sequence do? (You can test it in vim)
   - `v+p`
   - `6e`
   - `j`

LECTURE 5: SHELL SCRIPTING (1)

REFERENCE

- "Bash Guide for Beginners" [link]

GETTING STARTED

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Lecture 2: Files & directories Introduction: Shell ---

- Linux Shell
  - Linux shell is a *program* that interprets user *commands* from users and execute them by interacting with Linux OS kernel.
  - Different distributions:
    - `sh`: Bourne shell
    - `bash`: Bourne Again shell, superset of `sh`
    - others: `ksh`, `csh`

INTRODUCTION: SHELL SCRIPTING

- Two ways to put shell commands
  1. terminal: run commands one by one
  2. scripting: put shell commands in a file
- Why learn shell scripting/programming?
  - automate administrative tasks, save your efforts!
  - e.g. automatic software update, file backup, resource monitoring

SHELL SCRIPT BASICS: SHA-BANG

- Your first script
  - `#!` sha-bang is a two-byte magic number
  - basically says it's an executable shell script
- To execute a script `script.sh`:
  - `./script.sh`
  - `source script.sh`

SHELL SCRIPT BASICS: LANGUAGE

- Script is a group of commands:
  1. `#!/bin/bash echo 'hello world';`
- Variable:
  - Reference a variable: `$a`
  - untyped: integer, char, etc.
  2. `#!/bin/bash a=1;b=2;a=$a+$b;echo $a;`
  3. `#!/bin/bash a=1;b=2; a=$((a+b));echo $a;`
- If/else
  3. `if [ $a -gt $b ];then echo 'a larger than b`
     - `fi` declares the end of if/else clause

EXERCISE

1. Put commands `a=1;b=2;c=$a;a=$b;b=$c;echo $a,$b;` in a script, execute it, and put the printout to BB.
2. Write a script to initialize variables `a`, `b`, `c` with 1,2,3, and print their sum.
3. Write a script to swap the names of two files, file1 and file2. For example if input file1 contains Alice and file2 contains Bob at the beginning, after the execution, file1 should contain Bob and file2 should contain Alice.

COMMENTING

- # is used to comment in bash

LECTURE 6: SHELL SCRIPTING (2)

SHELL INITIALIZATION

- `~/.bash_profile`
  - The script runs when you open a terminal (`CTRL+T`) or so-called login
  - sample: `export PS1='\W> '`
- `~/.bashrc` (bash run commands)
  - The script runs when you run a new bash program (`bash`)
- These are user configuration files (not system-wide)

SHELL VARIABLES

- Global versus local
  - Global: environment variables
  - `env` to list all environment variables system-wide.
  - Global variable is propagated through all children bash, local var isn't
    - `export gvar=1; bash; echo $gvar; exit`
    - `lvar=1; bash; echo $lvar; exit`
- naming convention:
  - shell var name include char and digit
  - name does not start with digit: `1x=5` is invalid

SHELL VARIABLES: LIFE CYCLE

life cycle	local var	global var
define & init	`lvar=6`	`export gvar=7`
reference	`echo $lvar`	`echo $gvar`
destroy	`unset lvar`	

RESERVED AND SPECIAL VARIABLES

- Bash reserved variables:
  - `echo $HOME`
  - `echo $PATH`
  - `echo $PS1`: Prompt String
  - `echo $BASH; $BASH_VERSION`
- Bash special parameters:
  - `echo $?`: exit status of the last command executed
    - `echo alice; echo $?; rm nonexistfile; ech`

PASSING PARAMETERS

- Bash special parameters:
  - `echo $0`: name of shell
  - `echo $1,$2`: 1th,2nd shell parameter
  - `echo $*,$#`: all positional parameters and the number of these parameters
- Demo:
  - `#!/bin/bash echo $1; echo $2; echo $#;`

EXERCISE

1. Run script
   `#!/bin/bash a=$1; b=$2; echo $((a*b));`.
   - Put your command (to the script) and the result in BB. Explain briefly what it does.
2. Write a script to get 3 integers from the command-line and prints their product.
   - What happens if you do not pass the 3 required integers when running the script?
3. Write the command to add your name to the prompt string (`PS1`)
   - Test your command, and put the command to the BB.
   - Hint: to prepend `x` to variable `v`, use `v=x$v`

LECTURE 7: SHELL SCRIPTING (3)

QUOTING CHARACTERS

- Escape characters: \
  - `echo $date; echo \$date`
- Single quotes: '
  - Strongly preserve literal value
  - `echo '$date'`
- Double quotes: "
  - Weakly preserve literal value, except $ and \
  - `echo "$date"`
  - `echo "today is $date"`
  - `echo "I'd say \"Go for it\""`

SHELL EXPANSION

- Expand input string to output string

1. arithmetic expansion
   - `echo $((1+2))`
   - `echo $[1+2]`
2. tilde expansion
   - `ls ~`
3. variable expansion
   - `echo $BASH; echo ${BASH}apple`
   - `echo ${FRANKY:=franky}`

4. brace expansion
    - `echo sp{el,il,al}l`
    - `ls Lecture1.{pdf,pptx}`
5. file name expansion
    - `ls ./*.pdf`
    - `ls ./Lecture-T?.pdf`
    - `ls ./Lecture-T[12].pdf`
    - `ls ./Lecture-T[34].pdf`
6. command substitution:
    - replace command substitution with execution result
    - `echo $(date)`

ALIASES

- An alias allows a string to be replaced for another string when us
  word of a command
- `alias cd='cd /Users/tristartom/workspace/tea`
- `alias ls='ls -la'`
- `unalias ls`

EXERCISE

1. Write a command to printout the following text:
   `You said 'Today is Monday.'`
   - Upload the command to BB.
2. Edit your `~/.bash_profile` file so that you will be greeted upon login with words
   `welcome to the terminal`.
   - Upload the content of file `.bash_profile` to BB
3. Write *one* command to print the content of all files whose names are `file_a` and whose extensions are `txt` or `csv`.
   - Upload your command to BB.
4. Say your current directory has 9 files
   `1.txt`,`2.txt`,...`9.txt`. Write *one* command to print the contents of files `4.txt` and `9.txt`.
   - Upload your command to BB.

LECTURE 8: GREP & FIND

FILENAME EXPANSION AND FIND

Find command: find file by filename

1. `find . -name "*.c"` #
2. `find / -maxdepth 1 -type d`
   - `-maxdepth`: depth of directories to search
   - `-type d`: find directory, not files

GREP COMMAND

- Grep command: search file content

1. `grep hello hello.c`
2. `grep -r hello .`
   - `-r`: search files recursively in all descendant directories
3. `grep -i HELLO hello.c`
   - `-i`: the pattern is case-insensitive

- Notes
  - `find` searches file name, while `grep` searches file content
  - filename matching is *parameter expansion*, file content matching is *regular expression*.

REGULAR EXPRESSION

- A classic matching problem:
  - takes as input a string and "pattern", outputs a binary decision.
  - `match(al.*ce,alice)=1`
- Format of the pattern: **regular expression** (regex).
- Relevance to Linux shell: `grep`, search in `vim`

REGULAR EXPRESSION (2)

1. asterisk `*`: matching previous character repeating arbitrary times (including zero time).
   - `match(1133*,113)=1`
   - demo: `echo 113 | grep 1133*`
   - `grep(p,s)` finds *all* substrings in `s` that match pattern `p`
2. dot `.`: matching arbitrary single character
   - `match(13.,13)=0`
   - `match(13.,134)=1`
3. Brackets `[...]`: enclose a set of characters
   - `match(1[345],13)=1`, `match(1[345],15)=1`, `match(1[345],18)=0`
   - `match(1[3-5],14)=1`
   - `match(1[^3-5],14)=0`,`match(1[^3-5],18)=1`

3. caret `^`: beginning of a line
4. dollar sign `$`: end of a line
    - `^$` matches blank lines.

EXERCISE

1. Write a command to find all the files with name starting with `fil` under the current directory.
2. Given a file `file1` with `hello too`, try following commands, and report the result
   - `grep ^hello file1`
   - `grep hello$ file1`
   - `grep t[wo]o file1`
   - `grep ^[A-Z] file1`
3. Write a command to find all lines of all files under current directory recursively that contain a single word "hello".

LECTURE 9: COMMAND EXECUTION & PROCESSES

COMMAND EXECUTION

- Format: Command flag/options parameters
  - Execution result: `echo $?`
  - Repeat the same command: `history`, `!ls`
- Executing a command usually starts a new **process**
  - Run script in new process: `./script script.sh`
  - Run script in current process: `source script.sh`, `. script.sh`

OS PROCESS (1)

- Commands to list processes
  - `top`: Show all active OS processes on the machine (global)
    - For performance monitoring
  - `jobs`: Show all *children* processes created by the current process
  - `ps` (default): Show the processes attached (foreground) to a terminal
  - `ps aux`: Show all processes (similar to `top`)

OS PROCESS (2)

- File descriptor: binding (channel) between a file and process
  - standard output: `stdout`
  - standard err output: `stderr`
  - standard input: `stdin`
- Files: devices (keyboard, display), disk data files
  - A process can run in background/foreground of a display
- IPC: Inter-process communication
  1. Pipe
  2. Signals

REDIRECTION

- Redirect descriptor from one file to another
  - Descriptor `stdout` is attached to display (as a file).
  - It can be redirected to a disk file by append `>file_a` to a command
    - Overwrite: `echo 'hello Alice' >file_a`
    - Append: `echo 'hello Alice' >> file_a`
- Explicitly mentioning descriptor numbers
  - 1 is `stdout`
  - 2 is `stderr`
  - Ampersand `&` is both `stderr` and `stdout`
  - `rm nonexistfile > file_a`
  - `rm nonexistfile 1>file_a`,
    `rm nonexistfile 2>file_a`,
    `rm nonexistfile &>file_a`

EXERCISE 9.1

1. Try `pwd > zzz`; explain what this command does?
2. Write a command to store the list of files in current directory to a file named by 'f'

IPC: PIPE

- Chaining multiple commands
  - Connect the `stdout` descriptor of a previous command to the `stdin` of the current command. (like a pipe)
  - A pipe is a method of interprocess communication (IPC)
- Demo:
  1. `ls /etc | more`
  2. `ls /etc | vim -`
  3. `pwd | ls`

EXERCISE 9.2

1. Run command `ls /etc | grep conf$ > output`; explain what it does.
2. Design a command to output all files with `cis` in their name, using pipe. Don't use `find`.
   - hint: You can use `ls` and `grep`

IPC: SIGNALS & BACKGROUND

- Foreground/background:
  - multiple processes contend for a file
  - a process runs in background/foreground
  1. demo: run in foreground: `gedit`, `vim`
  2. demo: run in background: `gedit &`, `vim &`
- signals:
  - `<CTRL+Z>`: (keyboard) sends pause signal to the process in foreground
  - `<CTRL+C>`: (keyboard) sends quit signal to the process in foreground
  3. `<CTRL+C>`, `<CTRL+Z>`, `fg`
  4. Demo: `jobs`, `fg 1`: switch between multiple background processes

EXERCISE 9.3

1. Run `top`. now use `<ctrl+c>` to terminate it. run in another time and this time use `<ctrl+z>`. what is the difference?
2. Run `vim f1` in the background. also run `vim f2` in the background. try switching between them in one terminal.