Introduction to Unix/Linux

SDS335/398 Scientific/Technical Computing

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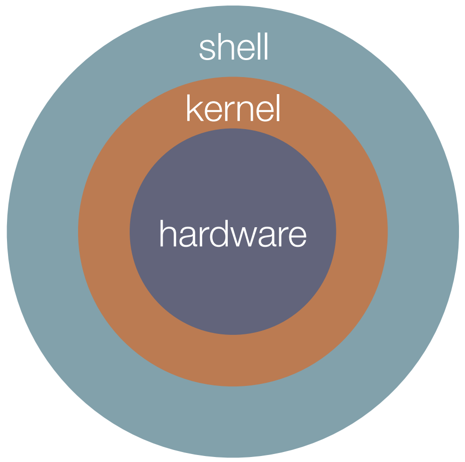
Unix/Linux OS

- Unix/Linux has a kernel and several different shells
- The shell is the command interpreter (ie the program that processes the command you enter in your terminal emulator (or in a process shell script).
- The kernel sits on top of the hardware and is the core of the OS; it receives tasks from the shell and performs them.



UNIX/Linux: Shell Flavors

There are two main ‘flavors’ of shells. We will be assuming the bash shell.

- Bourne created what is now known as the standard shell: “sh” or “bourne shell”. Its syntax roughly resembles Pascal. Its derivatives include “ksh” (“korn shell”) and now, the most widely used “bash” (“bourne again shell”)

- One of the creators of the C language implemented a shell to have a C like syntax “csh” “C-shell” Most people use the “tcsh” variant.

Hands-on: Login to class computers

- Use your EIDs to login to the class computers
  - Open ssh client (putty on the lab machines) or just Terminal on Mac
- Use your TACC username and password to ssh to isp.tacc.utexas.edu

Overview: Part 1 Introduction to UNIX/LINUX

1. **Very Basic Commands/Interacting with the shell** (remind me to give you the printed "cheat-sheet" https://files.fosswire.com/2007/08/fwunixref.pdf or I like this online cheatsheet too http://www.rain.org/~mkummel/unix.html

2. File attributes and permissions

3. UNIX/Linux Environment variables

4. Job control

5. Text Editors

Part 2 is ssh and remote systems, how to use TACC systems
Part 3 is advanced UNIX/Linux (more commands, shell scripting)

Hands-on: pwd, ls

- When you first login, you current working directory is your home directory. Your home directory has the same name as your user-name, and it is where your personal files and subdirectories are saved.
  Find out your current directory type:

```
$ pwd
```

- List what is in your directory type:

```
$ ls
```

`ls` lists only those ones whose name does not begin with a dot (.) Files beginning with a dot (.) are known as hidden files and usually contain important program configuration information.

List all the files:

```
$ ls -a
```

Note -a is one of the command options. There are many more. Find out more about any commands (including usage and options) use man

Hands-on: using ls *, find, locate

- List all of the shared library files (.so files in /usr/lib)

```
$ ls /usr/lib/*.so
```

- Or all the text files (.txt) in your local directory:

```
$ ls -lat /home/adb/*.txt
```

Where did I put that text file?
`find` lets you find files with various attributes on your filesystem
(more later, useful tutorial http://www.grymoire.com/Unix/Find.html)

```
$ find /home/adb/ -iname *list*
```

Where are the GL header files on the system?
`locate` will find all instances of file
(more later, useful tutorial https://www.unixtutorial.org/commands/locate/)

```
$ locate GL
```

Hands-on: man

Note -a is one of the command options. There are many more. Find out more about any commands (including usage and options) use man

```
$ man ls
$ man man
```

Hands-on: mkdir, cd

- Navigate to the parent directory you can use two dots:

```
$ cd ..
```

- You can navigate up the hierarchy using successive ../../../

```
$ ls ../../
$ cd ../../
```

- or the full path up the hierarchy

```
$ cd /home/adb/unix_tutorial
$ pwd
$ ls
```

If you are following along you are in /home and when you ls you can see everyone else home directory.

Hands-on: mkdir, cd

- Create a subdirectory in your home directory:

```
$ mkdir unix_tutorial
```

- See what you have created:

```
$ ls
```

- Go into that directory:

```
$ cd unix_tutorial
```

- See where you are:

```
$ pwd
```

- Create another subdirectory called “backups” and change to that directory. Check your directory structure with “pwd” and you should see:

```
$ pwd
/home/adb/unix_tutorial/backups
```

Hands-on: practice with cd to navigate the file system

- Navigate to the parent directory you can use two dots:

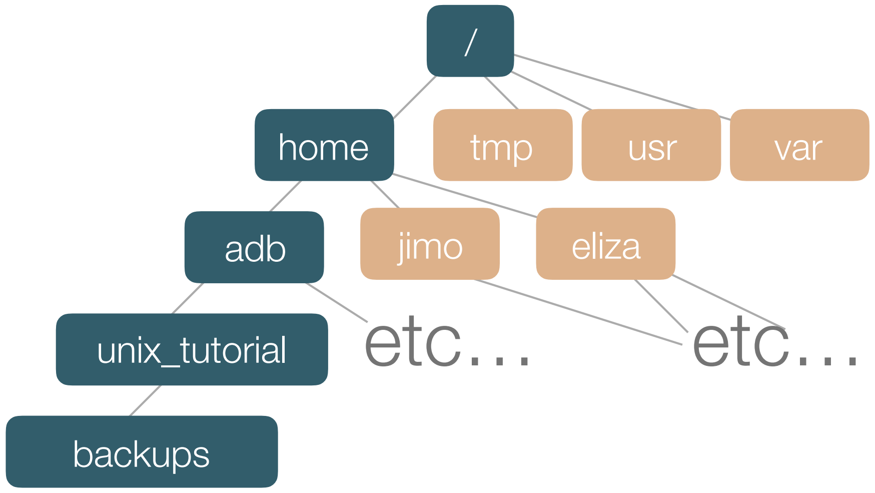
```
$ cd ..
```

- You can navigate up the hierarchy using successive ../../../

```
$ ls ../..
$ cd ../..
$ pwd
```

- or the full path up the hierarchy

```
$ cd /home/adb/unix_tutorial
$ pwd
$ ls
```



Hands-on: practice with cd to navigate the file system, ways to get home

If you are following along, you are in /home (can check with **`pwd`**, and when you **`ls`** you can see everyone else home directory
Note: If you ever need to get back to your home directory you can just type **`cd`** without any options:

```
$ cd
```

- the tilde is a shortcut to your home directory:

```
$ cd ~
```

- or you can specify the full path:

```
$ cd /home/adb
```

- or use the $HOME environment variable (on many systems):

```
$ cd $HOME
```

Summary: Very Basic Unix Commands

command	meaning
`ls [-a]`	list files and directories
`pwd`	display current directory
`mkdir`	make a directory
`rmdir`	remove a(n empty) directory
`cd [directory]`	change to named directory
`cd ..`	change to parent directory
`cd .. [../..]`	change to successive parent directories up the hierarchy
`man [command]`	get help on a command
`cd` or `cd ~`	change to home directory
`ssh [system]`	securely login to a remote machine
`find, locate`	useful for finding files

Hands on: cp

- Go into you unix_tutorial directory:

```
$ cd ~/unix_tutorial
```

remind me to tell you about tab-completion!

- Copy a file from my directory to your directory:
  Usage `cp <file1> <file2>`

```
$ cp /home/adb/theyearofspaghetti.txt .
$ ls -lt
```

- Notice the dot! The dot indicates the current directory. We are copying a file to our current directory and not changing the name. If you wanted to change the name you could:

```
$ cp /home/adb/theyearofspaghetti.txt spaghetti.txt
```

Hands on: mv, rm

- Let’s move the spaghetti.txt to our backups directory

```
$ mv spaghetti.txt backups

$ ls -lt
$ ls -lt backups
```

- the **`mv`** command is also used to rename files!

```
$ mv theyearofspaghetti.txt spaghetti.txt
```

- Create an extra copy of the text file so you can remove it:

```
$ cp theyearofspaghetti.txt tmpfile.txt
$ rm tmpfile.txt
```

- Be very careful with **`rm *`**
  If you are worried you can alias **`rm`** to **`rm -i`** or **`rm -I`** so the OS will prompt you before removing a file (we will see how to create aliases later), see **`man rm`**.

Hands-on: basic file manipulation (cat, less, head)

- Clear the terminal window:

```
$ clear
```

- Display the contents of a file on a screen:

```
$ cat theyearofspaghetti.txt
```

- Display the contents of a file on a screen, a page at a time:

```
$ less theyearofspaghetti.txt
```

- Display the first 10 lines of a file to the screen:

```
$ head theyearofspaghetti.txt
$ tail theyearofspaghetti.txt
```

Hands-on: searching files (less, grep)

- You can search through a text file for a keyword (pattern) using **`less`**

```
$ less theyearofspaghetti.txt
```

then, still in **`less`**, search with /

```
/spaghetti
```

`less` finds and highlights the search term. Type n to go to the next occurrence of the word
`grep` searches for files for specified words or patterns:

```
$ clear
$ grep spaghetti theyearofspaghetti.txt
$ grep Spaghetti theyearofspaghetti.txt
```

`grep` is case sensitive use the **`-i`** option to make it case insensitive

```
$ grep -i spaghetti theyearofspaghetti.txt
```

Hands-on: searching files (grep, wc)

- search for a phrase, enclose in single quotes:

```
$ grep "cooking spaghetti" theyearofspaghetti.txt
```

- How many words/lines is in this story?

```
$ wc -w  theyearofspaghetti.txt
$ wc -l  theyearofspaghetti.txt
```

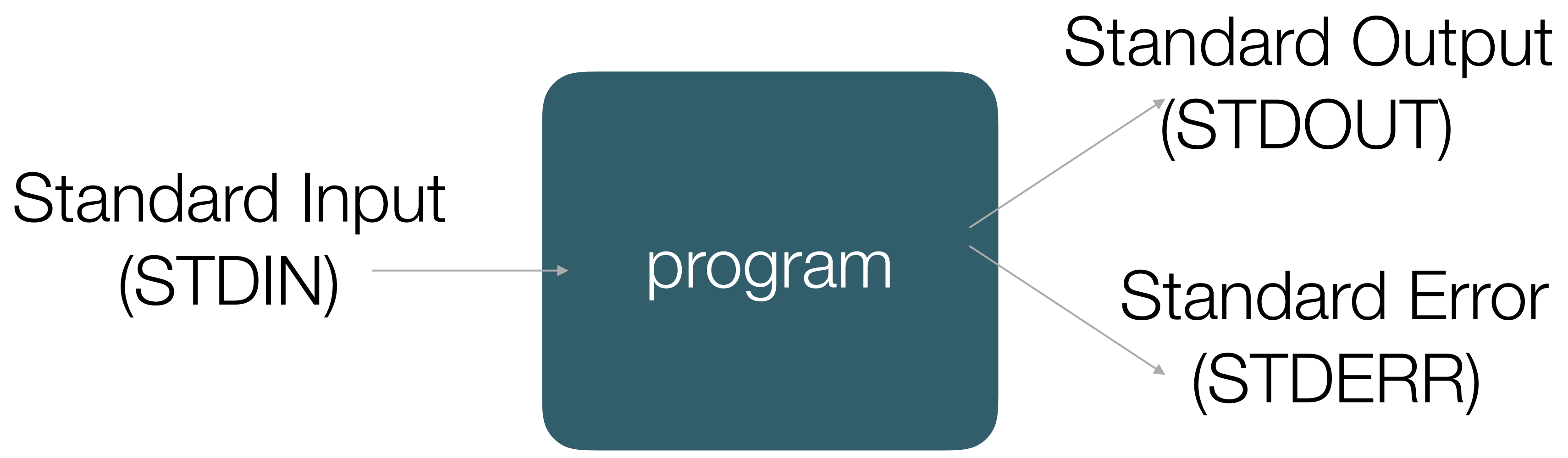
- grep has many useful options **`man grep`** and google for resources (https://www.computerhope.com/unix/ugrep.htm, for example) we will see more sophisticated examples later (parsing data with grep awk and sed)

Summary: more Unix Commands

command	meaning
`cp <file1> <file2>`	copy file1 to file2
`mv <file1> <file2>`	move/rename file1 to file2
`rm`	remove a file
`cat`	display a file
`more/less <file>`	display a file one screen at a time
`head/tail <file>`	display first/last 10 lines of file
`grep 'word' <file>`	search a file for ‘word’
`wc <file>`	count number of word/lines/chars

Redirecting output

- Typically in a UNIX environment you type in the name of a program and some command line options.
- The shell establishes 3 separate I/O streams: standard input, standard output and standard error.
- Most processes initiated by UNIX commands write to standard output (ie the screen), and take their input from standard input (the keyboard). There is also standard error.



Redirecting output

- The shell can attach things other than your keyboard to standard input:
    - A File (the contents of the file are fed to a program as if you typed it)
    - A pipe (the output of another program is fed as input as if you typed it)
- The shell can also attach things other than your screen to standard output:
    - A File (the output of a program is stored in a file)
    - A pipe (the output of another program is fed to the input of another program)

Hands-on: redirecting output

- To tell the shell to store the output of your program in a file, follow the command line for the program with the “>” character, followed by the filename:

```
$ ls /home > accounts.log
$ cat accounts.log
```

- You can concatenate two files using cat, and redirect the output to a new file:

```
$ cat theyearofspaghetti accounts.log > textblob.txt
```

- “>” will create (or overwrite) the file, if you want to append to and existing file use “>>”

```
$ whoami >> accounts.log
$ cat accounts.log
```

Hands-on: redirecting input

- the "**`sort`**" command will sort alphabetically or numerically, it takes input from standard input (the keyboard). To see how it works, type sort followed by a list of three fruits and then the key combo [Ctrl] and [d] to end the input (the Ctrl-D is the 'end of file' control sequence in UNIX

```
 $ sort
mango
tomato
apple
<[Ctrl][d]>
```

- type "**`who`**" to see who is currently logged into the system, and redirect the output from the screen to a file

```
$ who
$ who > users.log
```

- redirect the input of users.log to the command sort

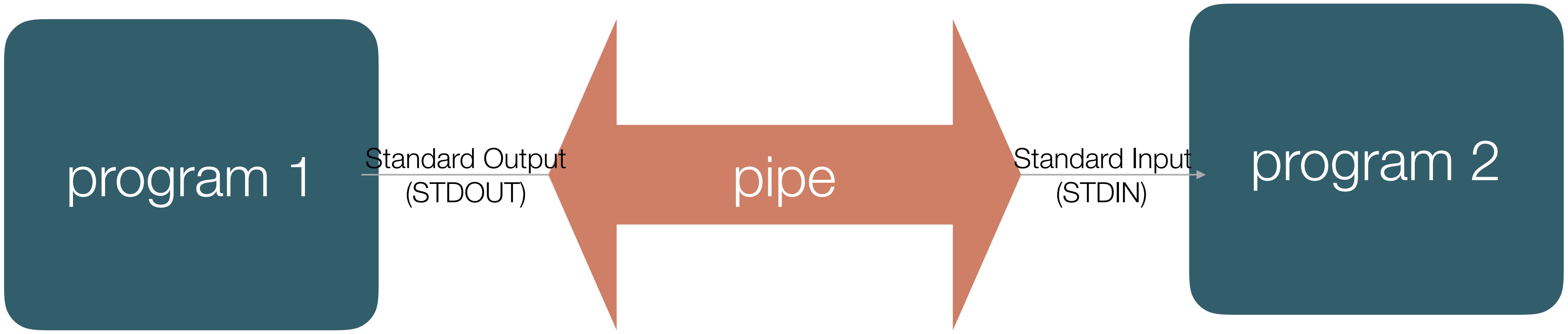
```
$ sort < users.log
```

- redirect the sorted output from standard out to a file

```
$ sort < users.log > sorted_users.log
```

Pipes

- A pipe is a holder for a stream of data
- A pipeline is a set of processes chained by their standard streams, so that the output of each process (stdout) feed directly as input (stdin) of the next one
- This is handy for using multiple commands together to perform a task



Hands-on: pipes

grep has a -o option which will output the word ONLY

- How many times does Haruki Muramaki use the word spaghetti in this short story?

```
$grep -oi "spaghetti" theyearofspaghetti.txt
$grep -oi "spaghetti" theyearofspaghetti.txt | wc -l
```

- other examples (| `less` useful in many cases when you have more than a screenful of text, | `grep` useful when you are looking for something) :

```
$ history | grep grep
$ ls -lat | less
$ who | sort
```

sed, awk and more advanced scripting preview

- We will learn about some more advanced file parsing with sed/awk later....but just to give you an idea:

```
7559640
crov-merge
C         -796.608          -44.387         1252.402
C         -796.461          -41.003         1253.900
C         -797.352          -38.541         1251.234
• etc
```

We will cover awk/sed more later in the data portion of the course...but here are some good tutorials if you can't wait:
http://www.grymoire.com/Unix/Sed.html
http://www.grymoire.com/Unix/Awk.html

- Example: malformed huge xyz file for an extremely large "girus"
  -needed to reorder the columns and substitute the atomic number for each element
  -very large file

```
grep '^[HNCSO] ' crov-allatoms.xyz   | awk '{print $2,$3,$4,$1}' | sed 's/N$/7/' | sed 's/C$/6/' | sed 's/S$/17/' | sed 's/H$/1/' | sed 's/O$/8/' > crov-allatoms.txt
```

- The ^ anchor specifies that the pattern following it should be at the start of the line
  -> awk which will print out columns, 2,3,4 and then 1
  -> sed will search for a N at the end of the line ($), and replace it with a 7 etc

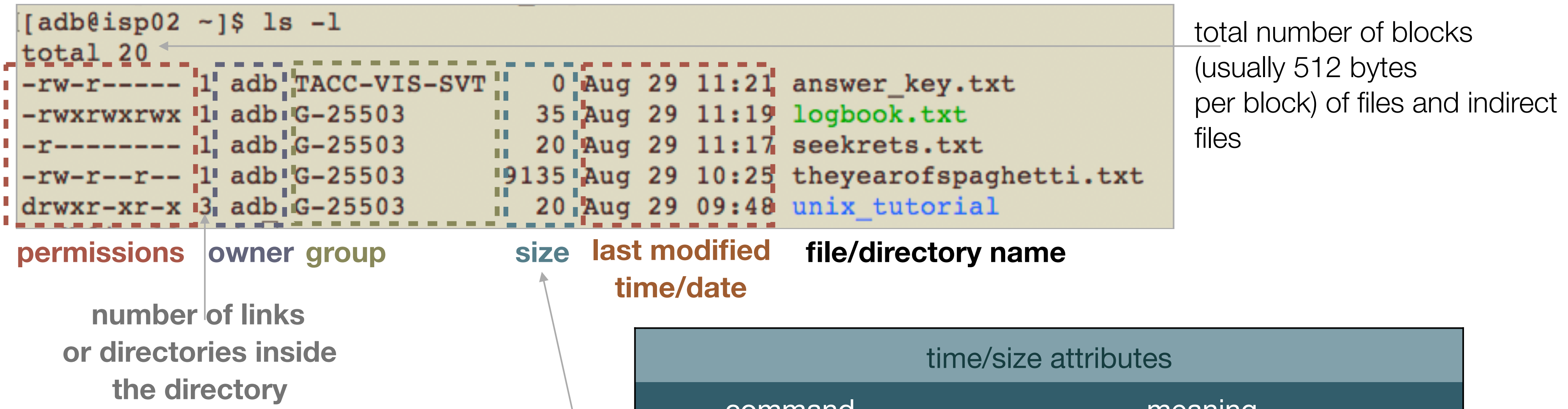
Summary: redirection and other Unix Commands

command	meaning
`command > file`	redirect stdout to file
`command 2> file`	redirect stderr to file
`command 2>&1 | tee`	redirect stderr and stdout to file AND screen
`command &> file`	redirect stderr and std out to file
`command >> file`	append stdout to file
`command < file`	redirect stdin from a file
`command1 | command2`	pipe the stdout of command1 to the stdin of command2
`cat file1 file2 > file3`	concatenate file1 and file2
`sort`	sort data
`who`	list of current users logged in
`wc <file>`	count number of word/lines/chars

Hands on: Introduction to UNIX/LINUX

1. Very Basic Commands/Interacting with the shell
2. **File attributes and permissions**
3. UNIX/Linux Environment variables
4. Job control
5. Text Editors
6. Remote Access

File Attributes and Permissions

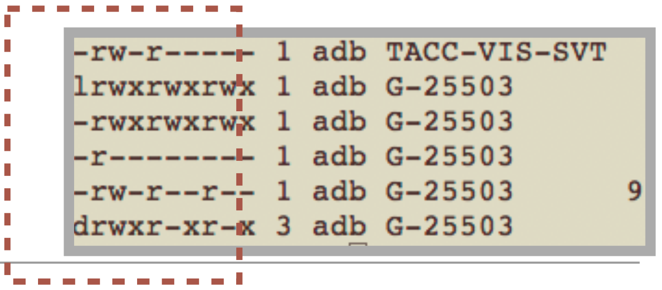


```
[adb@isp02 ~]$ ls -l
total 20
-rw-r-----  1 adb TACC-VIS-SVT    0 Aug 29 11:21 answer_key.txt
-rwxrwxrwx  1 adb G-25503        35 Aug 29 11:19 logbook.txt
-r--------  1 adb G-25503        20 Aug 29 11:17 seekrets.txt
-rw-r--r--  1 adb G-25503      9135 Aug 29 10:25 theyearofspaghetti.txt
drwxr-xr-x  3 adb G-25503        20 Aug 29 09:48 unix_tutorial
```

total number of blocks (usually 512 bytes per block) of files and indirect files
permissions
owner
group
size
last modified time/date
file/directory name
number of links or directories inside the directory

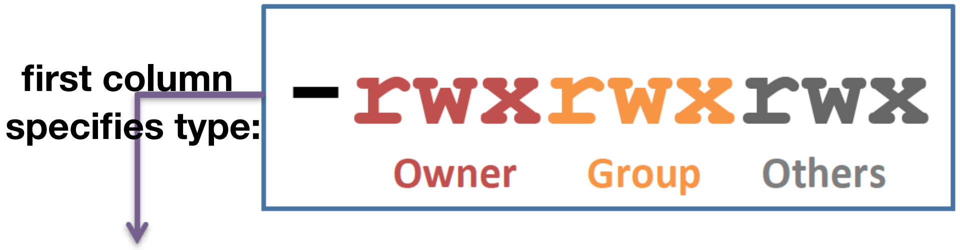
time/size attributes	
command	**meaning**
`ls -l`	when the file was last modified
`ls -lc`	when the file was last changed (change of wonder, permissions, etc)
`ls -lu`	when the file was last accessed
`ls -lt`	chronological listing
`ls -lh`	“human readable” size
`stat <filename>`	display date-related attributes

File Attributes and Permissions



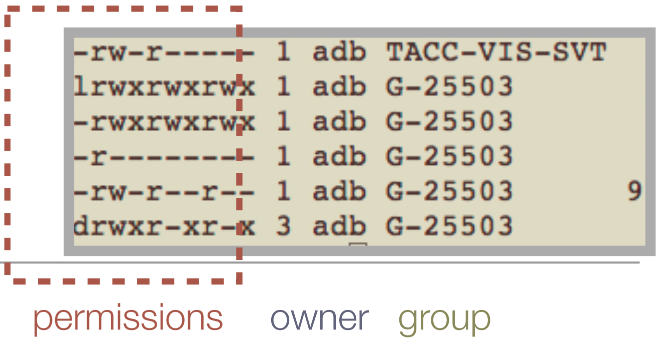
```
-rw-r----- 1 adb TACC-VIS-SVT
lrwxrwxrwx 1 adb G-25503
-rwxrwxrwx 1 adb G-25503
-r-------- 1 adb G-25503
-rw-r--r-- 1 adb G-25503        9
drwxr-xr-x 3 adb G-25503
```

- Each file has a set of *permissions* that control who can can access the file (and how). There are three different types of permissions:
  - read `r`, write `w`, execute `x`
  - In Unix/Linux, there are permission levels associated with three types of people that might access a file:
    - owner (you)
    - group (a group of other users that you set up or belong to)
    - world (anyone else browsing around on the file system)



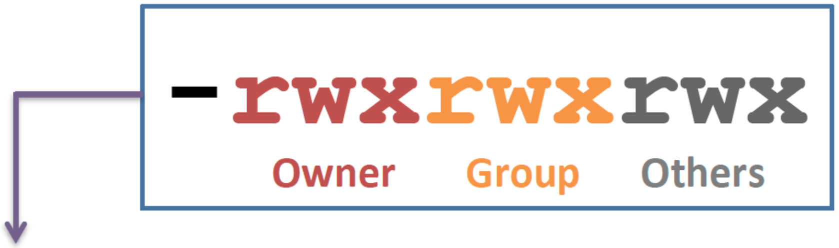
Symbol	File type
-	plain file
`d`	directory
`l`	symbolic link

File Attributes and Permissions



```
-rw-r-----  1 adb TACC-VIS-SVT
lrwxrwxrwx  1 adb G-25503
-rwxrwxrwx  1 adb G-25503
-r--------  1 adb G-25503
-rw-r--r--  1 adb G-25503        9
drwxr-xr-x  3 adb G-25503
```

- Meaning for Files:
  - `r` allowed to read
  - `w` allowed to write
  - `x` allowed to execute
- Meaning for Directories:
  - `r` allowed to see names of the files
  - `w` allowed to add and remove files
  - `x` allowed to enter the directory (This implies that you may read files in the directory provided you have read permission on the individual files.)



Symbol	File type
-	plain file
d	directory
l	symbolic link

Hands-on: File Attributes and Permissions

```
$ cd /home
$ ls
```

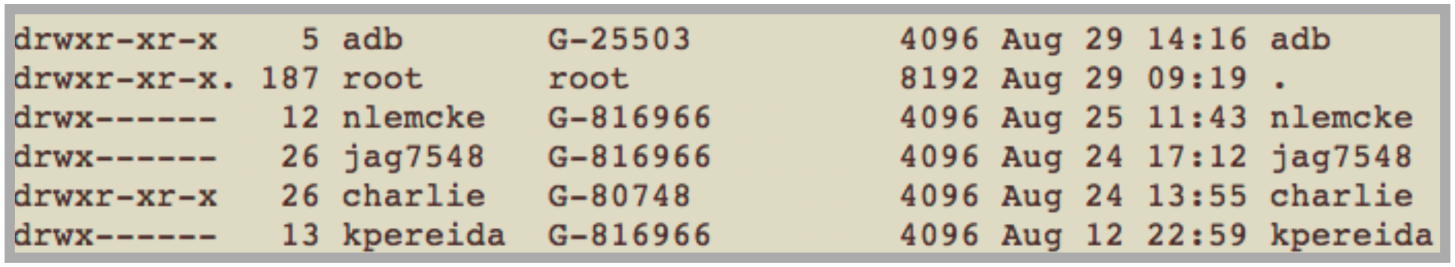
you should see all the home directories on the system.

- View the directory contents with “long format” to get more information and chronologically (sort by time with the newest first)

```
$ ls -lt
```

Hands-on: File Attributes and Permissions

- Notice my directory “adb” and the permissions. I have allowed group/world access to enter the directory (**`x`**) and see names of the files (**`r`**)



```
drwxr-xr-x     5 adb       G-25503          4096 Aug 29 14:16 adb
drwxr-xr-x. 187 root      root             8192 Aug 29 09:19 .
drwx------    12 nlemcke   G-816966         4096 Aug 25 11:43 nlemcke
drwx------    26 jag7548   G-816966         4096 Aug 24 17:12 jag7548
drwxr-xr-x    26 charlie   G-80748          4096 Aug 24 13:55 charlie
drwx------    13 kpereida  G-816966         4096 Aug 12 22:59 kpereida
```

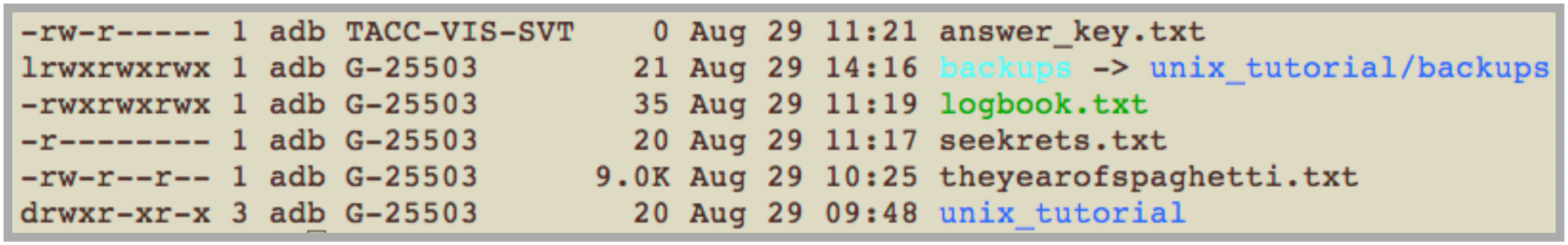
- The directory listing might have run off the page, to view the text one screen full at a time:

```
$ ls -lt | less
```

Hands-on: File Attributes and Permissions

- Enter the adb directory and list the contents in human-readable format:

```
$cd adb
$ls -lht
```



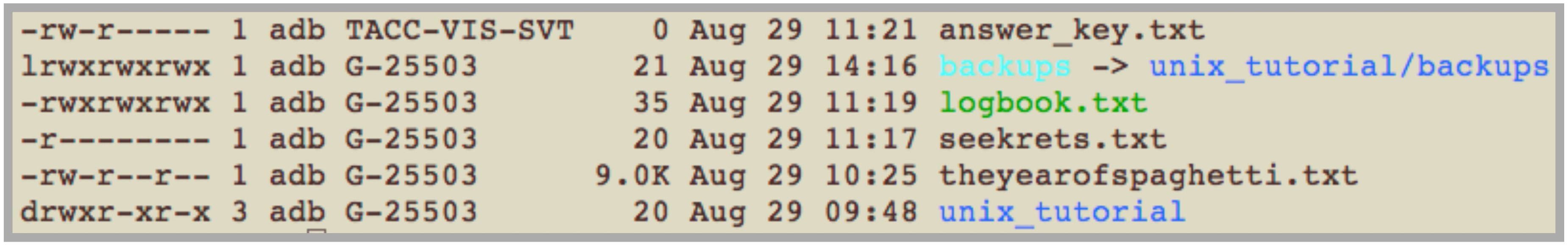
```
-rw-r-----  1 adb TACC-VIS-SVT    0 Aug 29 11:21 answer_key.txt
lrwxrwxrwx  1 adb G-25503        21 Aug 29 14:16 backups -> unix_tutorial/backups
-rwxrwxrwx  1 adb G-25503        35 Aug 29 11:19 logbook.txt
-r--------  1 adb G-25503        20 Aug 29 11:17 seekrets.txt
-rw-r--r--  1 adb G-25503      9.0K Aug 29 10:25 theyearofspaghetti.txt
drwxr-xr-x  3 adb G-25503        20 Aug 29 09:48 unix_tutorial
```

- Next we will modify permissions in our own home directories to see how to set up a shared folder as well as a private folder.

Changing File Permissions

- The chmod command changed the permissions associated with the file or directory. Only the owner of a file can use chmod to change the permissions of a file.
- Syntax `chmod [mode] <filename>`
- The mode can be specified by a symbolic representation or an octal number
- Both methods achieve the same result
- Multiple symbolic operations can be given separated by commas.

```
$cd adb
$ls -lht
```



```
-rw-r----- 1 adb TACC-VIS-SVT    0 Aug 29 11:21 answer_key.txt
lrwxrwxrwx 1 adb G-25503        21 Aug 29 14:16 backups -> unix_tutorial/backups
-rwxrwxrwx 1 adb G-25503        35 Aug 29 11:19 logbook.txt
-r-------- 1 adb G-25503        20 Aug 29 11:17 seekrets.txt
-rw-r--r-- 1 adb G-25503      9.0K Aug 29 10:25 theyearofspaghetti.txt
drwxr-xr-x 3 adb G-25503        20 Aug 29 09:48 unix_tutorial
```

chmod: symbolic representation

- Symbolic Mode representation has the following form:
- `[ugoa][+-=][rwxX…]`

`u` user	`+` add permission	`r` read
`g` group	`-` remove permission	`w` write
`o` other	`=` set permission	`x` execute
`a` all		`X` execute*
*The X permission option is very handy, it sets to execute only if the target is a directory or already has execute permission		

Hands-on: chmod, symbolic representation

Let’s experiment with changing permissions with files in our home directory:

- Go to your unix_tutorial folder in your home directory, note that the group for the class is G-819394:

```
$ cd ~/unix_tutorial
$ ls -lat
```

- Experiment with changing the owner (to yourself), group and permissions of theyearofspghetti.txt

```
$ chgrp G-819394 theyearofspaghetti.txt
$ chmod u-w,g+x,o=x theyearofspaghetti.txt
```

- Non-privileged users (not root) cannot chown files to other user names, but on your own machine you could:

```
$ chown yourname myfile.txt
```

chmod: octal representation

- Octal mode uses a single argument string which describes the permissions for a file (3 digits)
- Each digit of this number is a code for each of the three permission levels (user, group, world)
- Permissions are set according to the following numbers:
  Read bit will add 4 to the total (in binary 100)
  Write bit will add 2 to the total (in binary 010)
  Execute bit will add 1 to the total (in binary 001)
  Sum the individual permissions to get the desired combination. (e.g. if you want the owner only to have rwx permissions, group to have read only and world to have no access:

	Permission Level
0	no permissions
1	execute only
2	write only
3	write and execute (1+2)
4	read only
5	read and execute (4+1)
6	read and write (4+2)
7	read, write and execute (4+2+1)

owner	• 4(r)+2(w)+1(e)	7
group	• 4(r)+0(w)+0(e)	4
world	• 0(r)+0(w)+0(e)	0
`chmod 740 <filename>`		

Hands-on: chmod octal representation practice

think about it before you try it
and see the solution

- What would the following do:

```
$chmod 777 theyearofspaghetti.txt

$chmod 640 theyearofspaghetti.txt

$chmod 744 theyearofspaghetti.txt
```

Read = 4
Write = 2
Execute = 1
Sum the individual permissions to get the desired combination.

	Permission Level
0	no permissions
1	execute only
2	write only
3	write and execute (1+2)
4	read only
5	read and execute (4+1)
6	read and write (4+2)
7	read, write and execute (4+2+1)

Hands-on Exercise: permissions for a shared and private folder (symbolic or octal, your choice)

- Make a directory called “shared” and a directory called “private” and observe the permissions (ls -lat):

```
[adb@isp02 unix_tutorial]$ mkdir shared private
[adb@isp02 unix_tutorial]$ ls -lat
total 16
drwxr-xr-x 5 adb G-25503   76 Sep  1 12:20 .
drwxr-xr-x 2 adb G-25503    6 Sep  1 12:20 private
drwxr-xr-x 2 adb G-25503    6 Sep  1 12:20 shared
```

We want to make the permissions of the shared directory and the files inside open (rwx) for anyone in the group G-819394 and for the owner. We want to let anyone else on the system (ie world) be able to read the files only. To do that we need to make the parent directories readable and executable (`drwxr-xr-x`), and all the files inside readable, writable to the group, and just readable to the world (`-rwxrw-r–`). Note* since this is just a text file, we don’t need to worry about the executable permissions on the file.

Also, we want to make a private folder that is readable and writable only by the owner (you) (`drwx------`)

How would you do this? Give it a shot and then partner up with someone to see if they can access your directory and file (we won’t worry about writing to the file just yet)

Hands on: Introduction to UNIX/LINUX

1. Very Basic Commands/Interacting with the shell
2. File attributes and permissions
3. **UNIX/Linux Environment variables**
4. Job control
5. Text Editors
6. Remote Access

UNIX/Linux: Shell Flavors

There are two main ‘flavors’ of shells. We will be assuming the bash shell.

- Bourne created what is now known as the standard shell: “sh” or “bourne shell”. Its syntax roughly resembles Pascal. Its derivatives include “ksh” (“korn shell”) and now, the most widely used “bash” (“bourne again shell”)

- One of the creators of the C language implemented a shell to have a C like syntax “csh” “C-shell” Most people use the “tcsh” variant.

Customizing the Shell

- Each shell supports some customization:
  - user prompt settings
  - environment variable settings
  - aliases

- The customization takes place in startup files which are read by the shell when it starts up:
  -global files are read first -these are provided by the system administrators (e.g. /etc/profile)
  -local files are then read in the user’s HOME directory to allow for additional customization

Useful bash Aliases

- prevent common typo: `alias sl="ls"`
- prevent common typo protect yourself from rm *: `alias rm="rm -i"`
- list all files ordered by date: `alias lt="ls -alrt —color=auto"`
- use arguments: `alias histg="history | grep"`
- include burger in prompt: `export PS1="\\u@\h \\w 🍔 $ "`
  - `\u` username
    `\h` hostname
    `\w` current directory
  - find more: UNICDOE list of emoji's
    https://emojipedia.org/unicode-8.0/
  - google "unix prompt options" for more

Shell start-up files

sh,ksh:

```
~/.profile
```

bash:

```
~/.bash_profile
~/.bash_login
~/.profile
~/.bashrc
~/.bash_logout
```

csh:

```
~/.cshrc
~/.login
~/.logout
```

tcsh:

```
~/.tshrc
~/.cshrc
~/.login
~/.logout
```

Note: on TACC production systems, we provide an alternate location for customization files to avoid overriding system defaults:

BASH: `~/.profile_user`
CSH/TCSH: `~/.login_user`
`~/.cshrc_user`

Environment Variables:

- Unix/Linux shells maintain a list of environment variables which have a unique name and a value associated with them:
  -some of these parameters determine the behavior of the shell
  -also determine which programs get run when commands are entered (and which libraries they link against)
  -provide information about the execution environment to programs

- We can access these variables:
  -set new values to customize the shell
  -find out their values to accomplish a task

Hands-on: Environment Variables

- To view environment variables, us the **`env`** command

```
$ clear
$ env
```

- If you know what you are looking for, you can use grep

```
$ env | grep PWD
PWD=/home/adb
```

- Use the echo command to print variables the $ prefix is required to access the value of the variable:

```
$ echo $PWD
/home/adb
```

- Can also use the environment variable in conjunction with other commands:

```
$ ls $PWD
```

Special Environment Variable: PATH

- Each time you provide the shell a command to execute, it does the following:
  -Checks to see if the command is a built-in shell command
  -If it is not a built-in command, the shell tries to find a program whose name matches the desired command

- How does the shell know where to look on the file system
  The PATH variable tells the shell where to search for programs (non built in commands)

Special Environment Variable: PATH

- See what is in your $PATH

```
[adb@isp02 ~]$ echo $PATH
/opt/intel/advisor_2017.1.1.486553/bin64:/opt/intel/
vtune_amplifier_xe_2017.1.0.486011/bin64:/opt/intel/inspector_2017.1.1.484836/bin64:/
opt/intel/itac/2017.1.024/intel64/bin:/opt/intel//itac/2017.1.024/intel64/bin:/opt/
intel//itac/2017.1.024/intel64/bin:/opt/intel//clck/2017.1.016/bin/intel64:/opt/
intel/compilers_and_libraries_2017.1.132/linux/bin/intel64:/opt/intel/
compilers_and_libraries_2017.1.132/linux/mpi/intel64/bin:/opt/intel/debugger_2017/
gdb/intel64_mic/bin:/usr/local/bin:/usr/bin:/usr/local/sbin:/usr/sbin:/opt/intel/
bin:/usr/bin/tester:/home/adb/.local/bin:/home/adb/bin
```

- You can add more search directories to you PATH by changing the shell startup files:
  - BASH: export PATH=$PATH:/home/user/bin
  -TCSH: set path = (/home/user/bin $PATH)

-

Other important variables:

`PWD`	current working directory
`MANPATH`	where to find man pages
`HOME`	home directory of user
`MAIL`	where your e-mail is stored
`TERM`	what kinds of terminal you have
`PRINTER`	specifies the default printer name
`EDITOR`	used by many apps to identify editor pref (vi, emacs)
`LD_LIBRARY_PATH`	search path for dynamic runtime library

Setting Environment Variables:

- The syntax depends on your shell (for bash use export, tcsh use setenv):

```
$ export FRUIT=mango
$ echo $FRUIT
mango
```

- Note: environment variables that you set interactively are only available in your current shell:
  -if you spawn a new shell (e.g. `xterm&` or open a new tab via a GUI) these settings will be lost
  -to make permanent changes you can alter the login scripts that affect your shell e.g `.profile_user`

- (more on environment variables and the TACC module system coming soon)

Hands-on: Customizing your .bashrc

- On most production TACC systems the changes to your profile go in .profile_user but on isp.tacc.utexas.edu, we can edit our .bashrc

```
$ vi ~/.bashrc
```

- For practice, try creating an alias (as shown in previous slide) or change your prompt (http://www.linuxnix.com/linuxunix-shell-ps1-prompt-explained-in-detail/) :

- Check to see if it works

```
$ source ~/.bashrc
```

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Job Control

- The shell allows you to manage jobs:

  - place jobs in the background
  - move a job to the foreground
  - suspend or kill a job

- If you follow a command line with a “&”, the shell will run the job in the background

  - you don’t need to wait for the job to complete
  - you can type in a new command right away
  - you can have a bunch of jobs running at once

Hands-on: Job Control Example

- **`cat`** the contents of a file, decide it is taking too long so you want to kill it with **`<CTRL><C>`**

```
$cat theyearofspaghetti.txt
<CTRL><C>
```

- you try to **`find`** a file and realize it is taking a while and you want to suspend it and then run it in the background so you can use your prompt. Use **`<CTRL><Z> to background the process and then %n& (n is job number)`**

```
$ find / -iname GL > whereisGL.txt
<CTRL><Z>
  ^Z
  [2]+  Stopped                 find / -iname GL
$ jobs
  [1]-  Stopped                 vim touch.txt
  [2]+  Stopped                 find / -iname GL > whereisGL.txt
$%2&
```

- **`cat`** check the file to see if it did indeed finish in the background

```
$cat GL.txt
```

Job Control

command	meaning
`<CTRL><C>`	kill foreground job
`<CTRL><Z>`	suspend foreground job
`jobs`	list background jobs
`%n&`	run a suspended job in the background
`ps`	displays information about a selection of the active processes
`cat file1 file2 > file3`	concatenate file1 and file2
`&`	run job in background e.g. `$ longjob.sh&`
`fg %n`	Bring a background process to the foreground
`kill %n`	kill a process

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Text Editors: vi, emacs, nano, get me out

- From Wikipedia: "vi is a modal editor: it operates in either *insert mode* (where typed text becomes part of the document) or *normal mode* (where keystrokes are interpreted as commands that control the edit session). For example, typing i while in normal mode switches the editor to insert mode, but typing i again at this point places an "i" character in the document. From insert mode, pressing ESC switches the editor back to normal mode." It can be found on nearly every UNIX/Linux system in existence.
To exit, type :q<ENTER>

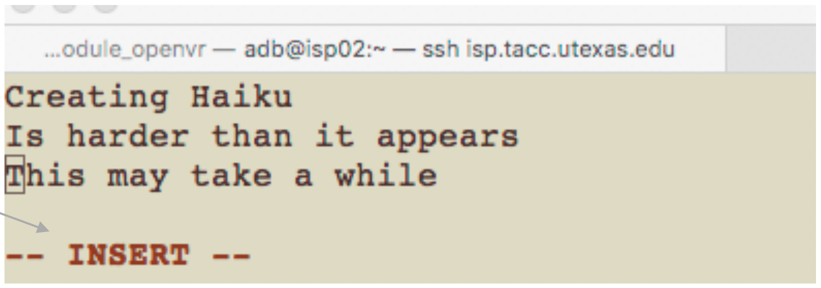
- Emacs is not modal but has thousands of commands and macros, usually in the form of a 1 or 2-key sequence (e.g. CTRL-n: "go to end of line"). To exit, type CTRL-X CTRL-C.

- Nano is more straightforward and shows its common commands at the bottom. To exit, type CTRL-X

Hands-on: Brief vi tutorial

- Edit a new file in vi but typing "vi filename.txt" , press `i` and type a

```
$ vi hello.txt
```



```
...odule_openvr — adb@isp02:~ — ssh isp.tacc.utexas.edu
Creating Haiku
Is harder than it appears
This may take a while

-- INSERT --
```

- Hit the escape key <Esc> to go into command mode, try:
  -navigating left, down, up, right with <h><j><k><l>
  -1st line of file :1 OR <1g>
  -last line of file :$ OR <g>
  -nth line of file :n OR <ng>
  -$ end of current line, ^ beginning of current line
  % show matching brace, bracket, parentheses
  /<string> search for a string

- Put your cursor on the last line of the file
  <yy> to yank (copy)
  <p> to put (paste)
  <dd> to delete the line
  <u> to undoPress `i` again and add some more text, <Esc> to go into command mode and save:
  :w save
  :wq save and quit (also could use :x or ZZ)
  :q! quit without saving

Hands on: brief vi tutorial

- search and replace in vi

```
$ vi theyearofspaghetti.txt
:%s/Id/I\'d/
```

- Notice we had to escape the ' using the back slash. The backslash (\) character is used to mark these special characters so that they are not interpreted by the shell, but passed on to the command being run (for example, **`echo`**).

- Here is a list of characters that have special meaning to the shell and might need to be escaped https://unix.stackexchange.com/questions/270977/what-characters-are-required-to-be-escaped-in-command-line-arguments/270979

- We will revisit this topic when get to some more advanced scripting topics (here is a good tutorial https://www.shellscript.sh/escape.html)

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preview of next session: ssh and scp

- ssh lets you securely connect to a remote system (as we did to connect to isp.tacc.utexas.edu)
- scp lets you securely copy files from one system to another. If you are on your own laptop, go ahead and try:
- `scp <localfilename> username@host:where/you/want/it/<filenameyouwant>`

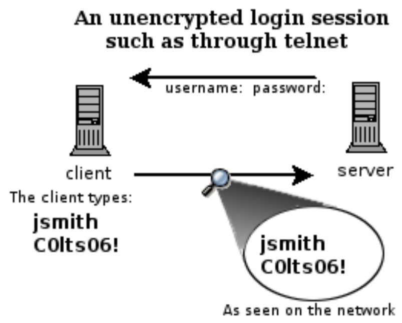
```
$ scp whipit.py adb@isp.tacc.utexas.edu:unix_tutorial/whipit_fromLaptop.py
adb@isp.tacc.utexas.edu's password:
whipit.py
100% 5568    49.5KB/s   00:00
adb:Desktop adb$
```

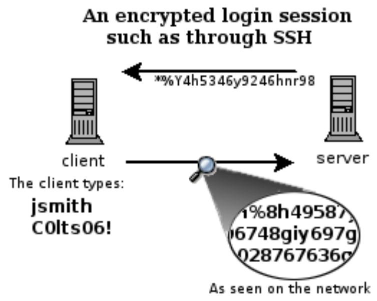
- can also scp files from a remote to local:
- `scp username@host:where/you/want/it/<filenameyouwant> .`
- notice that there is a dot . that will use your pwd and keep the same filename

```
$ scp adb@isp.tacc.utexas.edu:theyearofspaghetti.txt .
adb@isp.tacc.utexas.edu's password:
Permission denied, please try again.
adb@isp.tacc.utexas.edu's password:
theyearofspaghetti.
```

What is ssh?

- There are a couple ways you can access a shell remotely on most Linux/Unix systems.
- Some are insecure (e.g. telnet) everything that you send or receive over that telnet session is visible in plain text on your local network, and the local network of the machine you are connecting to. So anyone who can "sniff" the connection in-between can see your username, password, email that you read, and commands that you run.





- SSH, which is an acronym for Secure SHell, was designed and created to provide the best security when accessing another computer remotely. Not only does it encrypt the session, it also provides better authentication facilities, as well as features like secure file transfer, X session forwarding, port forwarding and more so that you can increase the security of other protocols.