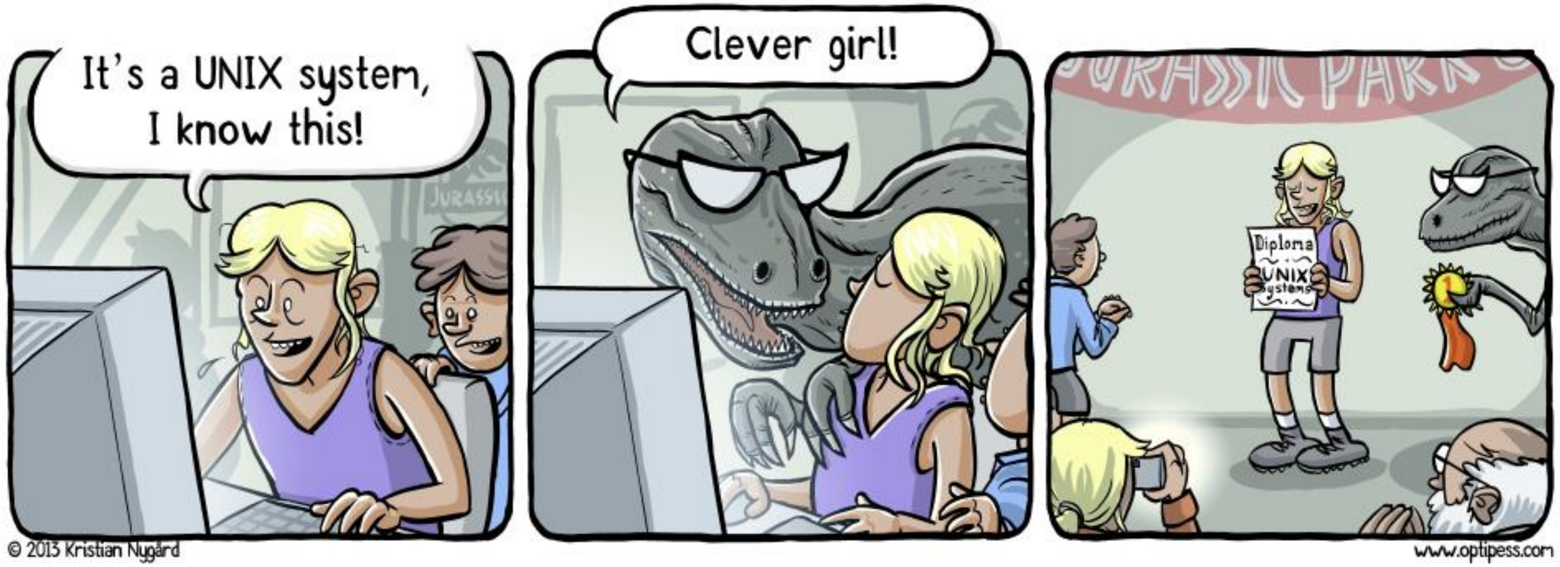
1878

Western

UNIVERSITY · CANADA

Files and Directories

Winter 2022



Western

File and Directory Types

- What is a file?
  - A container for data
  - Persistent (stays around)
  - Accessible by a name
- In Unix, EVERYTHING is a file

File and Directory Types

- Unix file types (https://en.wikipedia.org/wiki/Unix_file_types)
  - Regular
  - Directory
  - Device
  - Link
  - Others

File and Directory Types

- Behind the scenes, the name in a directory is translated to a specific location on disk (disk # → cylinder # → track # → sector # → block #). This is known as an "inode number" (index node number).

- This is why it is called a "directory" instead of a "folder". The directory contains an index of files (like the index in a book). The files do not physically "live" inside a folder.

File and Directory Types

- Regular file
  - Text file – Contain "printable" characters
  - Binary file – Contain any ASCII characters from 0 to 255

File and Directory Types

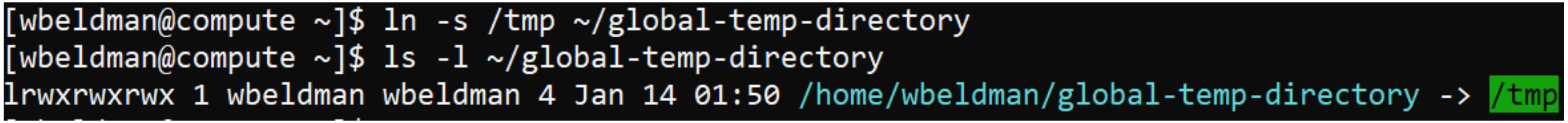
- Directory ("file")
  - Contains the names and inode numbers for all files and directories in this directory
  - We treat it like a folder

File and Directory Types

- Device file
  - Allows I/O from a device (e.g. Soundcard, mouse, etc.)
- Links
  - Hard links
  - Soft links
    - Like a shortcut

File and Directory Types

- Links (continued)
  - Soft links are popular and are often called "symbolic links" or "symlinks"
  - ln -s <target directory> <link name>



```
[wbeldman@compute ~]$ ln -s /tmp ~/global-temp-directory
[wbeldman@compute ~]$ ls -l ~/global-temp-directory
lrwxrwxrwx 1 wbeldman wbeldman 4 Jan 14 01:50 /home/wbeldman/global-temp-directory -> /tmp
```

File and Directory Types

- How do you find out what type a file is? Three suggestions:
  - ls -F
  - ls -l
  - ls --color=auto
  - (or all of them: ls -F -l --color=auto)

Pathnames and links

- Unix has directories and subdirectories. When referring to a path (e.g. the cd command), you will use one of two types
  - Absolute path
  - Relative path

Pathnames and links

- Absolute path
    - Begins with a / (the root)
    - Explicitly uses the entire path from root all the way to the subdirectory
    - E.g. /home/wbeldman

Pathnames and links

- Relative path
  - Dependent on what your current working directory is. E.g.
  - cd tmp - means change directory to tmp <u>inside</u> my current working directory. This is not the same as cd /tmp

Pathnames and links

- When referring to a location in the system, your command will check in the following order
  - / - The root
  - ~ - The home directory
  - . – The current directory (./ to be more explicit)
  - .. – The parent directory (../ to be more explicit)
  - Otherwise try the current working directory

Pathnames and links

- E.g. If I am in /home/wbeldman, the following are all equivalent
  - /home/wbeldman/cs2211/readme.txt
  - ~/cs2211/readme.txt
  - cs2211/readme.txt
  - ~/cs2211/otherfolder/../readme.txt

Pathnames and links

- Another way to combine shortcuts are like this:
  - cd ../../../ - Go up three directories in the tree
- When running a command found in the current working directory (e.g. your compiled C program), use the ./ shortcut
  - ./myProgram

Wildcarding

- We can use special characters to represent a sequence of other characters
- When using a wildcard to match multiple files, this is known as "globbing"
  - * – matches 0 or more characters
  - ? – matches exactly one character
  - […] – matches any <u>one</u> character in the list

Wildcarding

- E.g.
  - a*.c* matches a**bc**.c and a**bra**.c**pp**
  - a?.c matches a**b**.c, a**x**.c, but not abc.c
  - b[aei]t matches **bat**, **bet**, or **bit**, but not but or baet
  - b[!aei]t matches **but** but not bat, bet, bit, or baet

Wildcarding

- E.g. combining sequences
  - mv a*.[ch] cfiles/ – move all files beginning with a and ending in .c or .h into cfiles
  - ls [abc]*.? – list all files beginning with a, b, or c, followed by (possibly) anything, followed by a dot, followed by a single character

Wildcarding

- Wildcards do not traverse directories. It only matches in the current directory
    - E.g. csnow*c does NOT match csnow/**code**c
- Wildcards do not match "hidden files". Hidden files are files that start with a . (dot)
    - E.g. "cat *profile" will not find ".bash_profile"

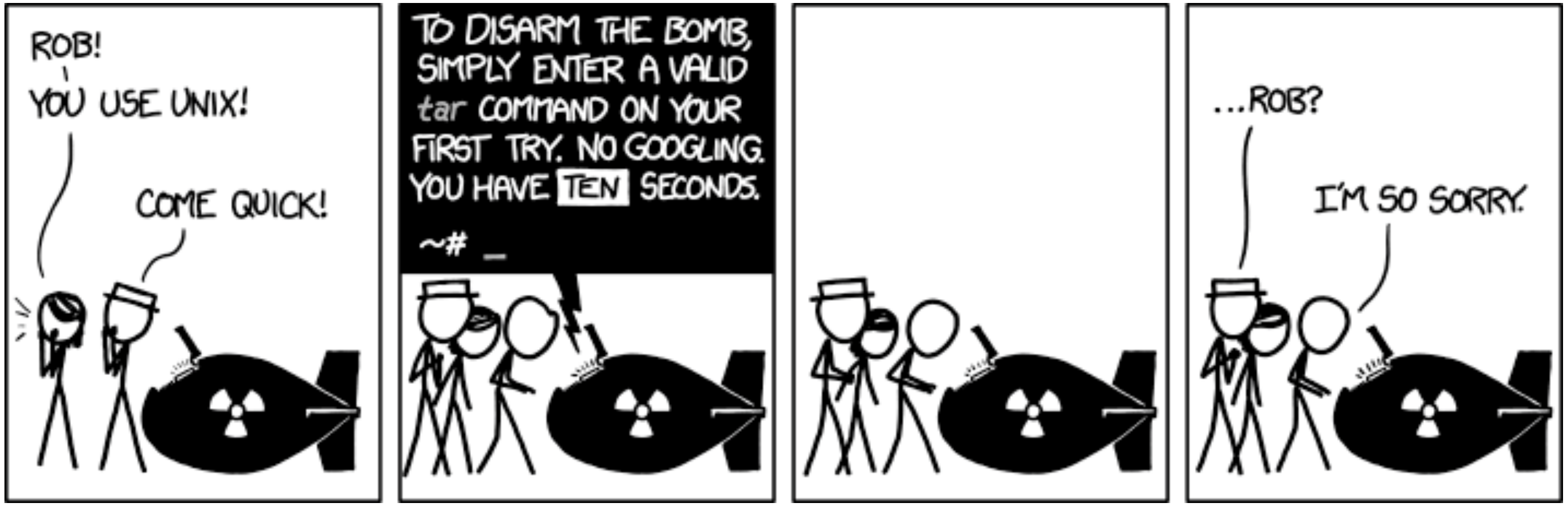
Wildcarding

- […] allows a range of characters instead of explicitly listing each one
    - E.g. ls [a-z]* matches all files beginning with a-z
- The wildcard expansion is done by your shell, NOT by the program you are running
    - E.g. When "ls *" is run, it is actually doing "ls file1.txt file2.txt file3.txt …"

Wildcarding

- Other advanced examples to think about
  - ls /bin/*[–_]*
  - What’s the difference between ls * and ls
  - mv *.bat *.bit – This does not rename all .bat files as .bit files as you might expect

Tar


ROB!
YOU USE UNIX!
COME QUICK!
TO DISARM THE BOMB, SIMPLY ENTER A VALID tar COMMAND ON YOUR FIRST TRY. NO GOOGLING. YOU HAVE TEN SECONDS.
~# _
...ROB?
I'M SO SORRY.

Tar

- An archiving command
- Used to "bundle up" a directory and make a single file out of it, or "unpack" a file into a new directory
- The resulting file by convention has a .tar extension and is called a "tarball"
- Great for backups/snapshots, submitting your code in the assignments ;)

Tar

- To create a tarball out of a directory called Assignment2, use
  - tar cvf Assignment2.tar Assignment2
  - c == create, v == verbose, f == filename
- To create Assignment2 out of a tarball, use
  - tar xvf Assignment2.tar
  - x == extract, v == verbose, f == filename

Tar

- You might recognize this as zipping or unzipping a directory
- Technically this is not exactly the same because the tarball is not compressed/uncompressed
- If you supply z as in cvzf/xvzf, this will create an archive file <u>and</u> compress it. By convention, we use .tar.gz as the extension

Finding files

- Use find to recursively locate files in a large directory structure
- A very powerful tool that can (among many things)
    - Match wildcards in file names
    - Match based on file size, permissions, creation time, etc.
    - Execute commands on each file found

Finding files

- To use find, the syntax follows the format:
  find <path> <expression>
  e.g.

  - find ./ -name "README" – Find all files and directories under the current directory called "README"

  - find /usr/include -name "*.h" – Find all files and directories under /usr/include ending in .h

Finding files

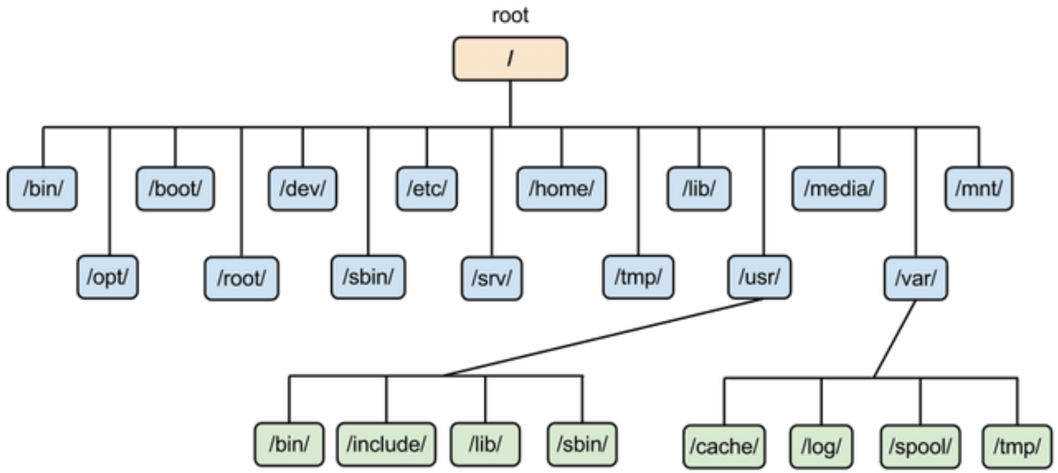
- More examples
  - find ./ -type f -name "README" – Find all files (but not directories) under the current directory called "README"
  - find ./ -type d -name "README" – Find all directories (but not files) under the current directory called "README"

Finding files

- Use "man find" to read the manual and discover more options

The Unix File System

- A Unix filesystem is organized like an upside down tree

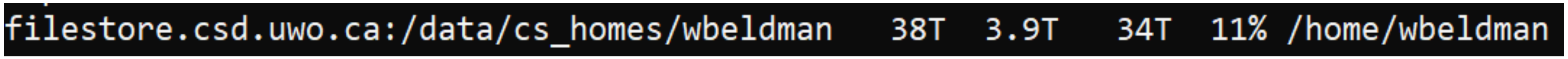


The Unix File System

- The top of the file system is known as the "root" directory and is identified with a single slash (/)
  - This is NOT the same as a backslash (\ ) which is commonly used in Windows
  - What kind of files are stored in which directory are done by convention only.

The Unix File System

- The Unix file system can transparently span multiple disks (including network attached disks).
- As a regular user, you don't actually need to know this detail, nor should you care
- You can use the df command to see other disks



```
filestore.csd.uwo.ca:/data/cs_homes/wbeldman   38T  3.9T   34T  11% /home/wbeldman
```

The Unix File System

- Some common directories in Unix

– /	the root
– /bin	**bin**aries (executables)
– /dev	**dev**ices (peripherals)
– /devices	where the **devices** really live
– /etc	startup and control files
– /lib	**lib**raries (really in /usr)
– /opt	**opt**ional software packages
– /proc	access to **proc**esses
– /sbin	**s**tandalone **bin**aries
– /tmp	place for **temp**orary files

– /usr	**us**e**r** stuff
– /usr/bin	**bin**aries again (user)
– /usr/include	**include** files for compilers
– /usr/lib	**lib**raries of functions etc.
– /usr/local	**local** stuff
– /usr/local/bin	local **bin**aries
– /usr/local/lib	local **lib**raries
– /usr/openwin	X11 stuff
– /usr/sbin	sysadmin stuff
– /usr/tmp	place for more **temp**orary files
– /usr/ucb	**ucb** binaries
– /var	**var**iable stuff

The Unix File System

- /bin – contains small executable programs (binaries). This is where you find the common commands you are used to (e.g. ls, cd, mkdir, etc.)
- /sbin – contains small executable programs (binaries) but are only used by the system administrator.
- /lib (and /usr/lib) – contains binary library files that other programs might call (e.g. stdio.h)

The Unix File System

- /dev – Everything in Unix is a file – even devices. This directory contains device files (see slide 8) e.g. disk drives, input devices
- /boot – The OS kernel lives here. The heart of the operating system. If the rest of the Unix system is broken, you at least need /boot to be available so the OS can boot up

The Unix File System

- /etc – Contains system configuration files (regular files). The OS and other programs typically store their configuration information in this directory

- /proc – Virtual files that represent the current state of the kernel. Processes can refer to files here to retrieve information about the system or other processes

The Unix File System

- /mnt – Commonly used to hold sub-directories that are temporarily mounted. This could be something like /mnt/cdrom or /mnt/windows for dual-boot systems
- /usr – Stores programs and files used by end-users. Non default stuff usually goes here. Think of this like C:\Program Files
- /var – Variable data files. Typically log files

The Unix File System

- /home – Contains the home directories for any user with a login to the system (except root). A home directory is the user’s personal space

- /root – The home directory of the "root" user

The Unix File System

- /tmp – Contains temporary files and directories. Accessible by everyone. Many systems periodically purge this directory so DON’T store important files here!
- /opt – Some large applications will choose to bundle all their files and directories here instead of /usr, /etc, /bin, etc.

Working with directories

- We covered making and removing directories already. Let’s look at moving and copying directories

Working with directories

- A directory is just a file, so you move it the same as you would any other file:
    - mv <directory1> <directory2> - Moves <directory1> into <directory2>

Working with directories

- Copying is a little different. You have to explicitly tell cp that you want to copy the directory and any files below it.

- Use the -r argument to copy recursively. E.g.

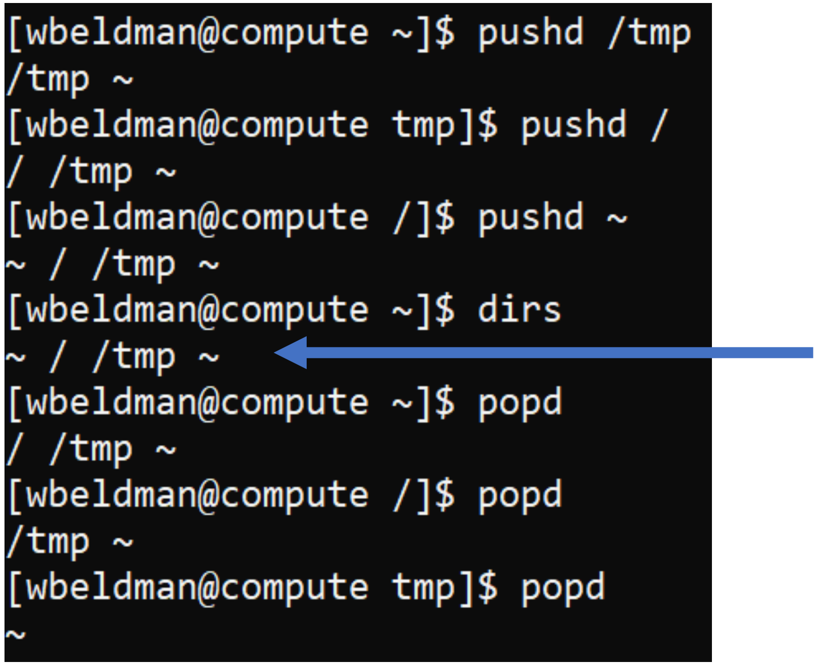
  - cp -r <directory1> <directory2> - Copy directory 1 and everything below it into directory 2

Working with directories

- pushd and popd can be used to maintain a list (a stack) of directories
  - pushd <directory1> - change directory to directory1 and put directory1 on top of the stack
  - popd - change directory to the top of the stack and remove it from the stack
- The current stack is also printed for you

Working with directories

- Use the dirs command to display the current stack



```
[wbeldman@compute ~]$ pushd /tmp
/tmp ~
[wbeldman@compute tmp]$ pushd /
/ /tmp ~
[wbeldman@compute /]$ pushd ~
~ / /tmp ~
[wbeldman@compute ~]$ dirs
~ / /tmp ~
[wbeldman@compute ~]$ popd
/ /tmp ~
[wbeldman@compute /]$ popd
/tmp ~
[wbeldman@compute tmp]$ popd
~
```

File names

- Almost any character can be in a filename except / and the "null" character
  - Still, don’t use these special characters: ? * [ ] " ‘ ( ) & : ; !
  - Don’t use these as the first character: - ~
  - If you do, you're gonna have a bad time!

File names

- Unix is case sensitive. Upper and lower case are different. A.txt and a.txt are different files

- Unix doesn’t use extensions.
  a
  a.
  .a
  …
  a.b.c
  Are all valid filenames

File names

- Unix is case sensitive. Upper and lower case are different. A.txt and a.txt are different files
- Unix doesn't use extensions.
  a
  a.
  .a
  …
  a.b.c
  are all valid filenames

File names

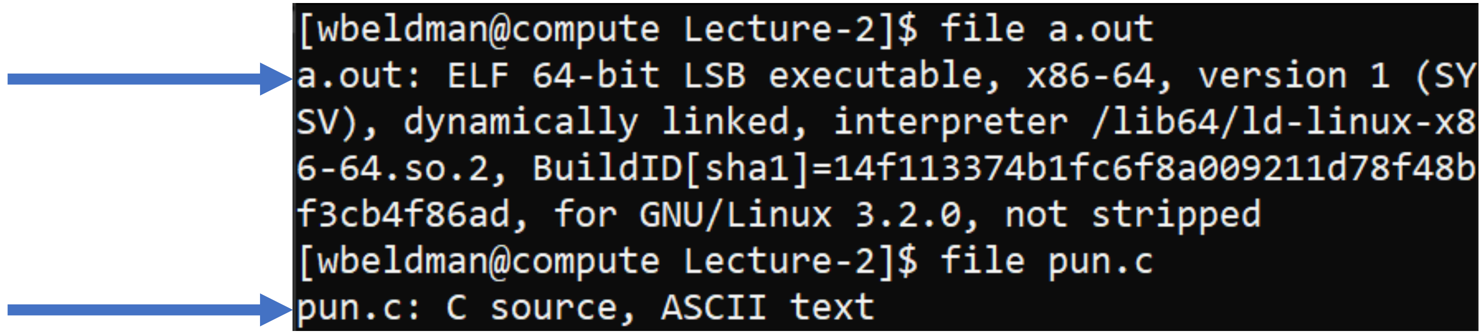
- Extensions are still useful to the user so in practice they are still used. E.g.
    - .c means a C program
    - .jpg for a JPEG image file
    - .txt means a text file
    - .mp3 for a music file

File names

- Executable files do not have an extension either. Windows usually uses the .exe extension.
- There are limits to the length of the name
  - Typically 255 characters for a file name and 4096 characters for the entire path

File names

- Use the "file" command to gather info on a file



```
[wbeldman@compute Lecture-2]$ file a.out
a.out: ELF 64-bit LSB executable, x86-64, version 1 (SY
SV), dynamically linked, interpreter /lib64/ld-linux-x8
6-64.so.2, BuildID[sha1]=14f113374b1fc6f8a009211d78f48b
f3cb4f86ad, for GNU/Linux 3.2.0, not stripped
[wbeldman@compute Lecture-2]$ file pun.c
pun.c: C source, ASCII text
```

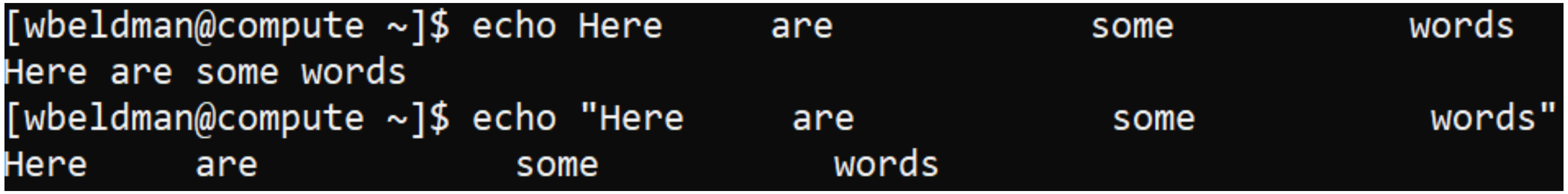
File names

- Files beginning with a . (dot) are "hidden" files. ls will not list them by default. You have to use "ls -a"
- You have a bunch of these in your home directory already. These typically hold personal configuration files rather than storing them in /etc for all to see

Unix Quoting

- Use quotations marks to stop the shell from interpreting special characters (e.g. whitespace, *, or ~)

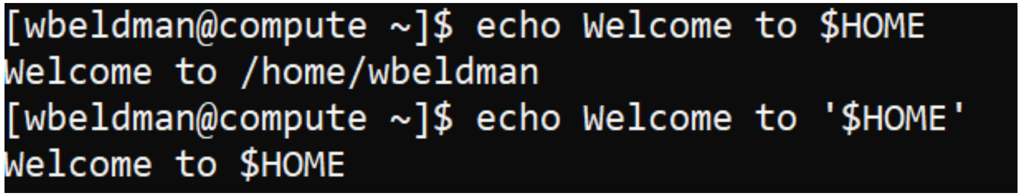
- Here’s an example with "



```
[wbeldman@compute ~]$ echo Here     are            some           words
Here are some words
[wbeldman@compute ~]$ echo "Here     are            some           words"
Here     are            some           words
```

Unix Quoting

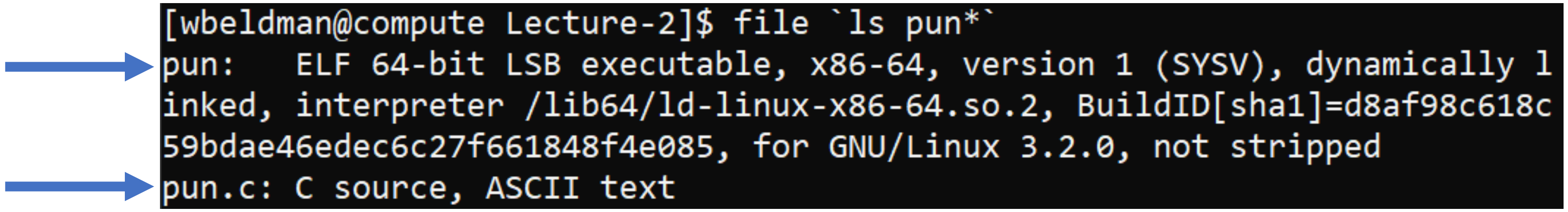
- Here’s an example with ‘



```
[wbeldman@compute ~]$ echo Welcome to $HOME
Welcome to /home/wbeldman
[wbeldman@compute ~]$ echo Welcome to '$HOME'
Welcome to $HOME
```

Unix Quoting

- You can use ` (backtick) to "insert the results of a command". E.g.

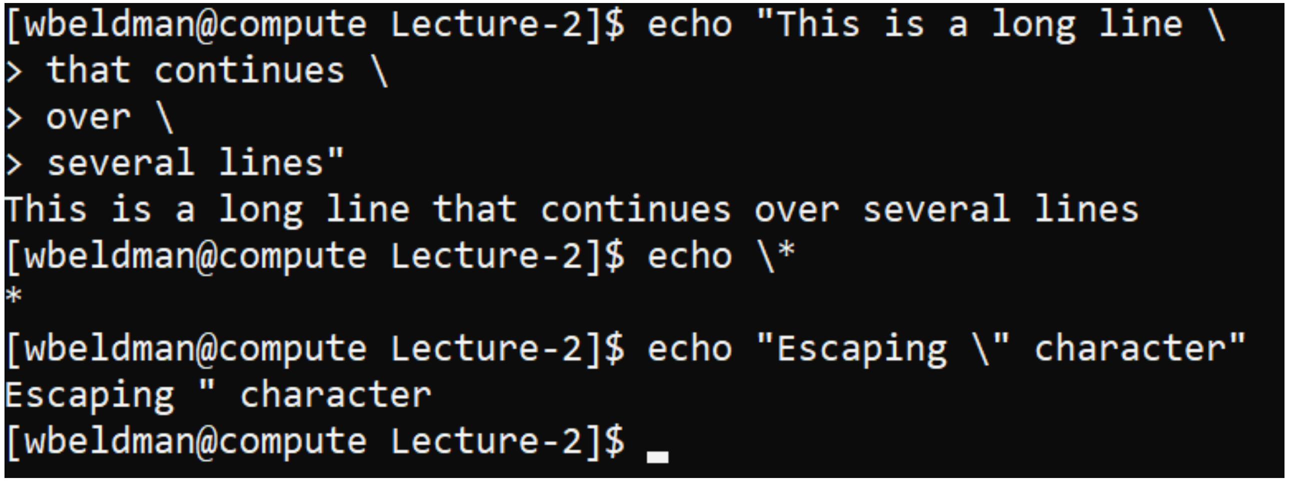


```
[wbeldman@compute Lecture-2]$ file `ls pun*`
pun:    ELF 64-bit LSB executable, x86-64, version 1 (SYSV), dynamically l
inked, interpreter /lib64/ld-linux-x86-64.so.2, BuildID[sha1]=d8af98c618c
59bdae46edec6c27f661848f4e085, for GNU/Linux 3.2.0, not stripped
pun.c: C source, ASCII text
```

- Note that a backtick (`) and single quote (‘) are not the same!

Unix Quoting

- The backslash "quotes" or "escapes" the next character (like a newline or another special character). E.g.



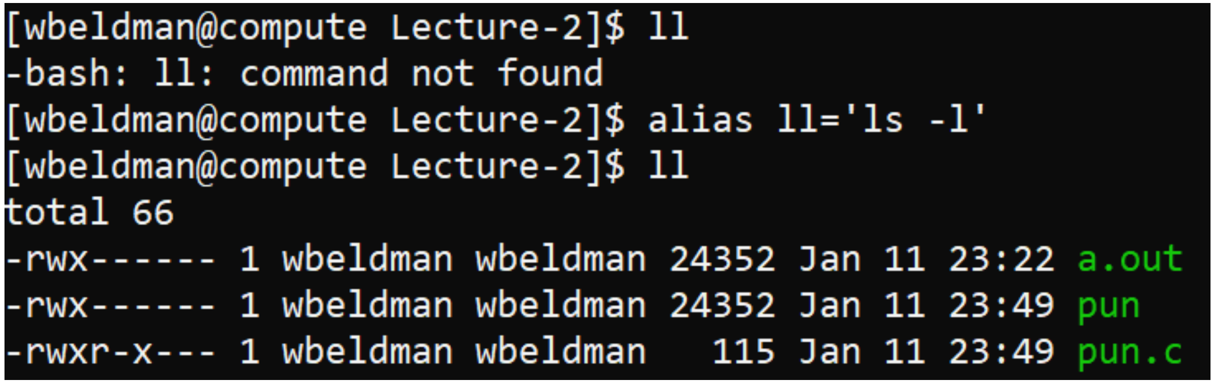
```
[wbeldman@compute Lecture-2]$ echo "This is a long line \
> that continues \
> over \
> several lines"
This is a long line that continues over several lines
[wbeldman@compute Lecture-2]$ echo \*
*
[wbeldman@compute Lecture-2]$ echo "Escaping \" character"
Escaping " character
[wbeldman@compute Lecture-2]$ _
```

Miscellaneous

- A few other useful commands to know
  - head <filename> - View the first few lines of a file
  - tail <filename> - View the last few lines of a file

Miscellaneous

- A few other useful commands to know
  - alias <mycommand>=<another command>



```
[wbeldman@compute Lecture-2]$ ll
-bash: ll: command not found
[wbeldman@compute Lecture-2]$ alias ll='ls -l'
[wbeldman@compute Lecture-2]$ ll
total 66
-rwx------ 1 wbeldman wbeldman 24352 Jan 11 23:22 a.out
-rwx------ 1 wbeldman wbeldman 24352 Jan 11 23:49 pun
-rwxr-x--- 1 wbeldman wbeldman   115 Jan 11 23:49 pun.c
```

Miscellaneous

- A few other useful commands to know
  - which <command> - Where is a command located. The command whereis works similarly. This can help you find out if a command is installed or not.
  - whatis <command> - A one-liner description of <command> (This is drawn from the man page)

Miscellaneous

- A few other useful commands to know
  - clear – clear all the text off of the screen
  - history – a running history of all the commands you have run
  - touch <filename> - Updates the "update time" on a file. If <filename> does not exist, this is a useful way to create a new empty file

Miscellaneous

- A few other useful commands to know
  - echo "Some Text" – Write "Some Text" to the screen. This will be very useful when writing shell scripts
  - grep "Some Text" <filename> - Search for "Some Text" inside <filename>

1878

Western

UNIVERSITY · CANADA