The Filesystem

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- The Filesystem
- Navigating the filesystem
- Users & Permissions
- Working with files
- Archives

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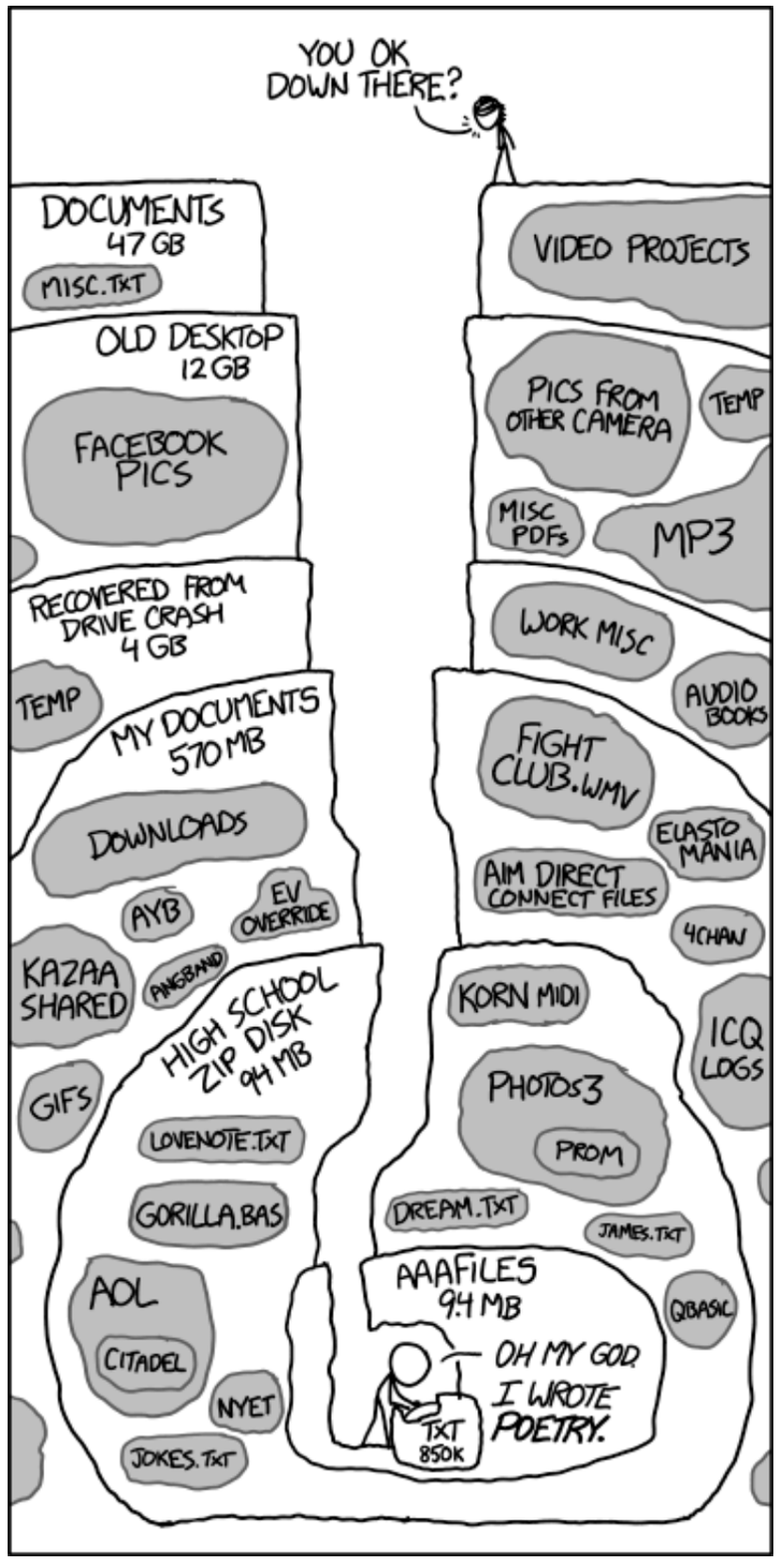
“I think the major good idea in Unix was its clean and simple interface: open, close, read, and write.”

— Ken Thompson

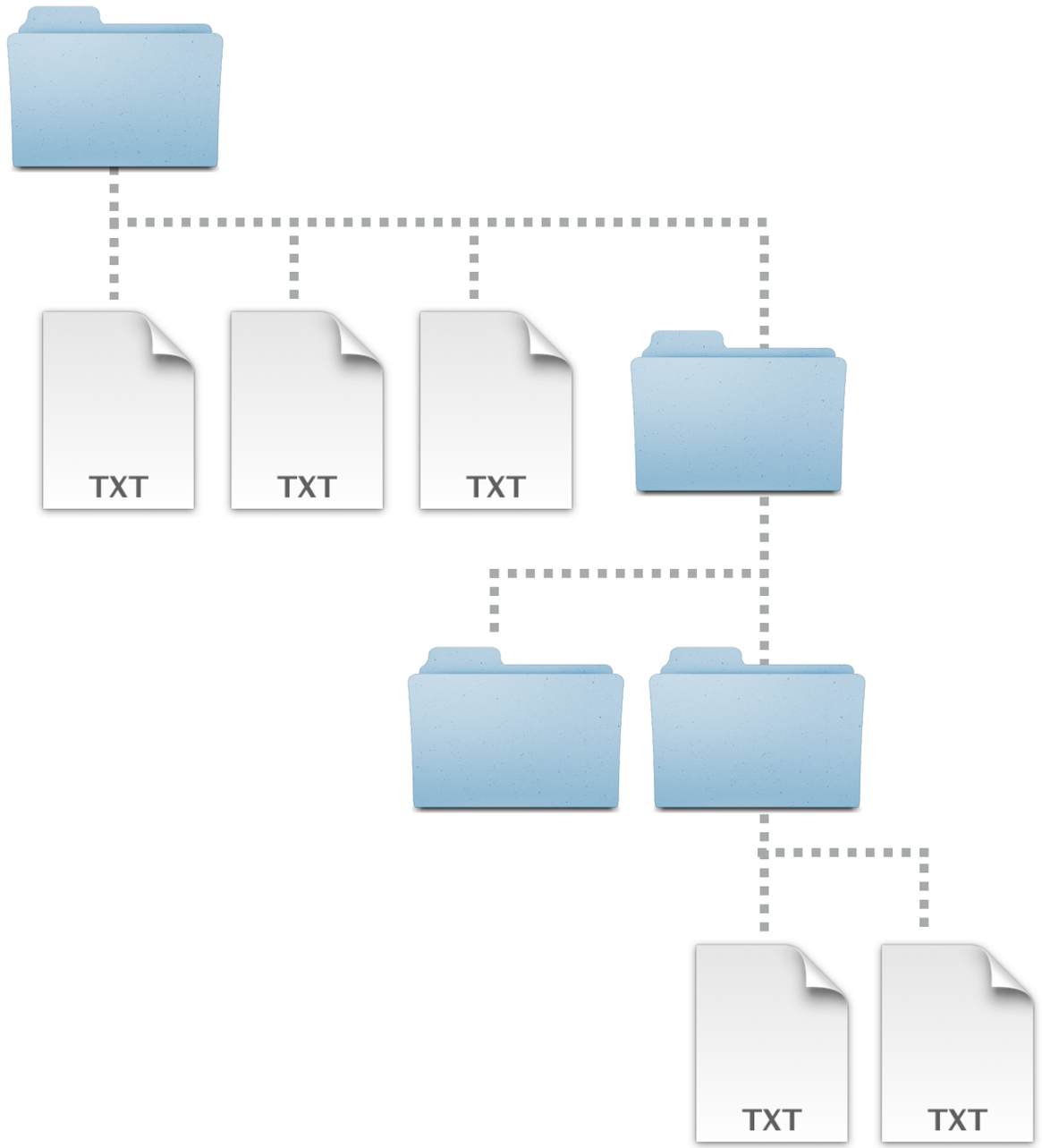
"On a UNIX system, everything is a file; if something is not a file, it is a process."

— Unknown


YOU OK DOWN THERE?
DOCUMENTS 47 GB
MISC.TXT
OLD DESKTOP 12 GB
FACEBOOK PICS
RECOVERED FROM DRIVE CRASH 4 GB
TEMP
MY DOCUMENTS 570 MB
DOWNLOADS
AYB
EV OVERRIDE
KAZAA SHARED
ANGSBAND
HIGH SCHOOL ZIP DISK 94 MB
GIFS
LOVENOTE.TXT
GORILLA.BAS
AOL
CITADEL
NYET
JOKES.TXT
VIDEO PROJECTS
PICS FROM OTHER CAMERA
TEMP
MISC PDFs
MP3
WORK MISC
AUDIO BOOKS
FIGHT CLUB.WMV
ELASTO MANIA
AIM DIRECT CONNECT FILES
4CHAN
KORN MIDI
ICQ LOGS
PHOTOS3
PROM
DREAM.TXT
JAMES.TXT
AAAFILES 9.4 MB
QBASIC
OH MY GOD I WROTE POETRY.
TXT 850K

The Filesystem

- The Linux filesystem is hierarchical.
- It has a tree like structure that begins at the “root” node.
- Each node in the tree can be a file or directory (or link, socket…).
- A directory is a special file that contains a list of other files, and can include other directories.
- Each “file” in the filesystem has a name, which is case sensitive (afile is not the same as AFILE).
- Each “file” or node in the tree has a unique identifier called it’s **inode**.

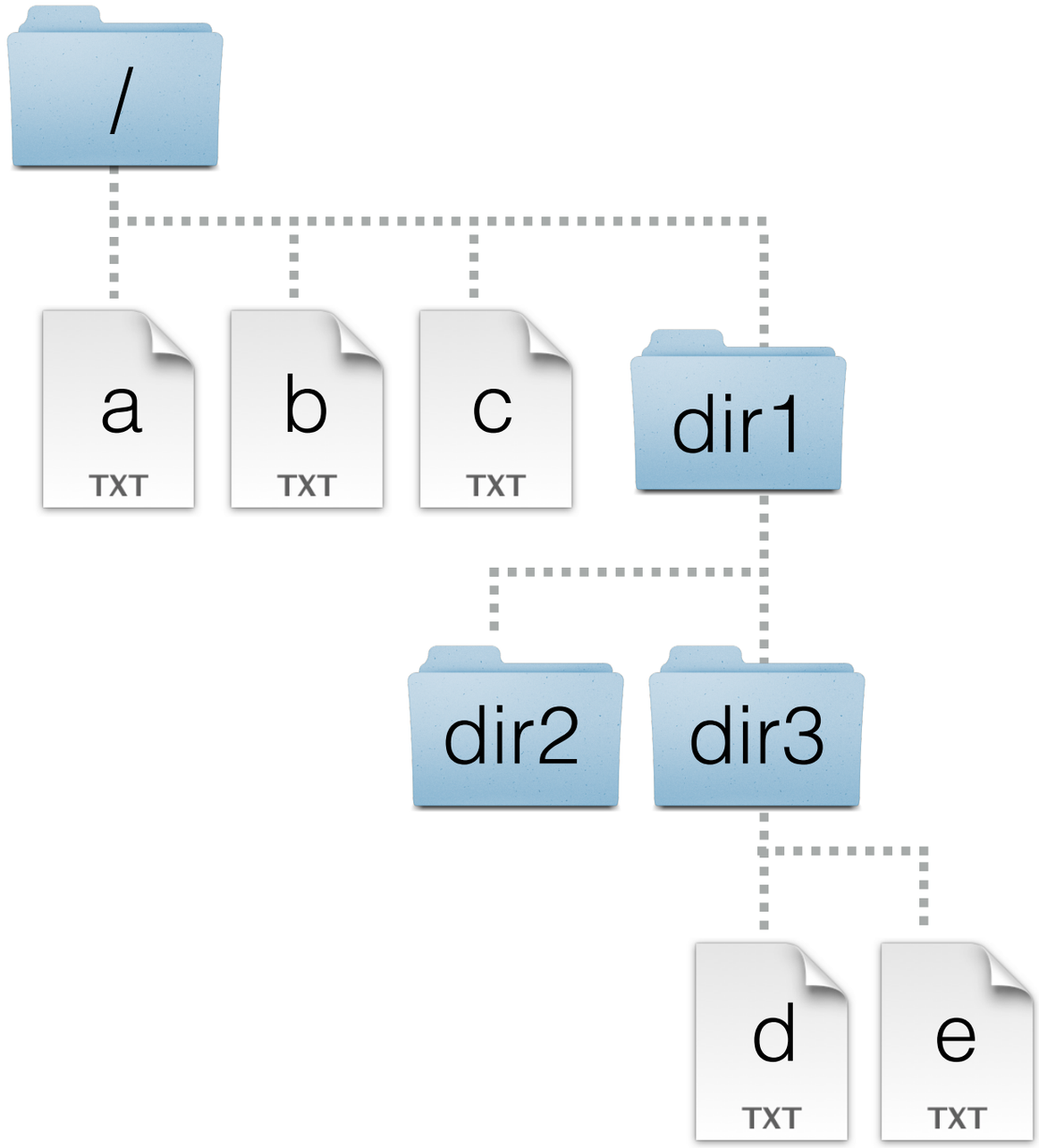


File types

Type	Symbol	Purpose
Regular	-	Standard text files
Directories	d	Files that are lists of files
Links	l	A special file that allows another file to appear in multiple locations in the filesystem.
Special File	c	Input / Ouput sources (usually located in /dev)
Sockets	s	inter process networking similar to TCP/IP
Named Pipes	p	Similar to a socket, allows process to communicate with one another.

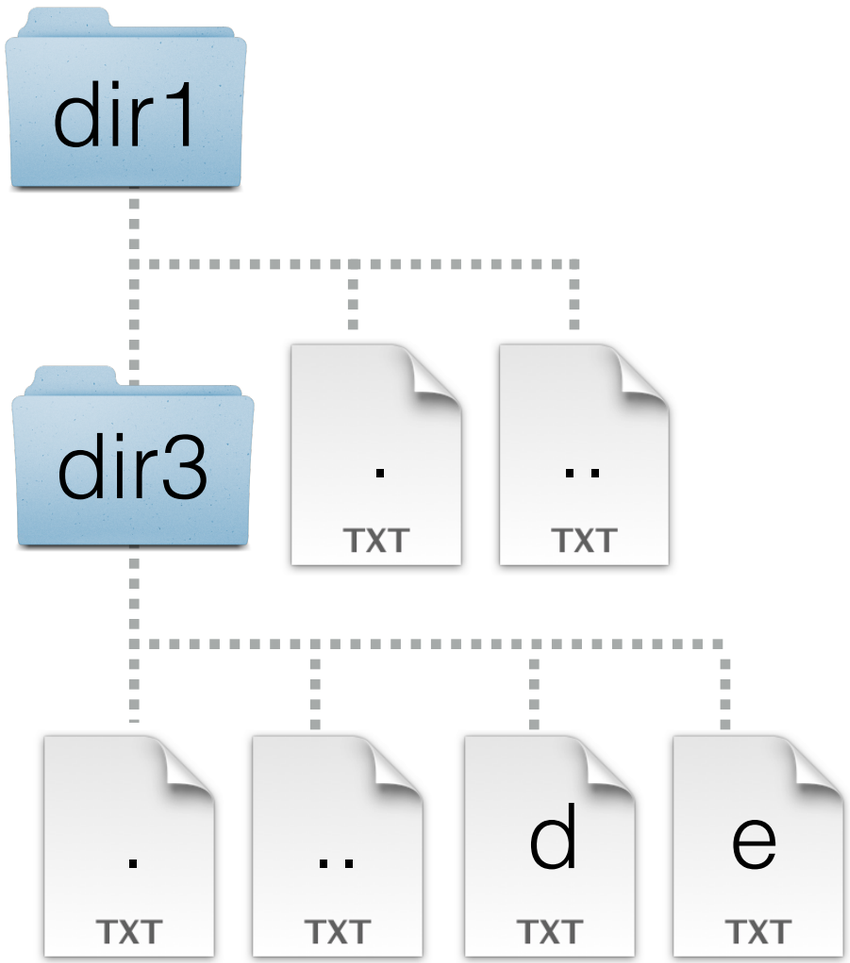
Absolute File Paths

- The location of each file is given by its **path**.
- The absolute path starts from the “root” node denoted by a **/**
- In this example the absolute path for the file ‘a’ would be **/a**
- Each time we descend into a directory we add an additional **/**
- So the absolute path for the file ‘e’ would be **/dir1/dir3/e**
- We can locate any file in the filesystem by using it’s absolute path.



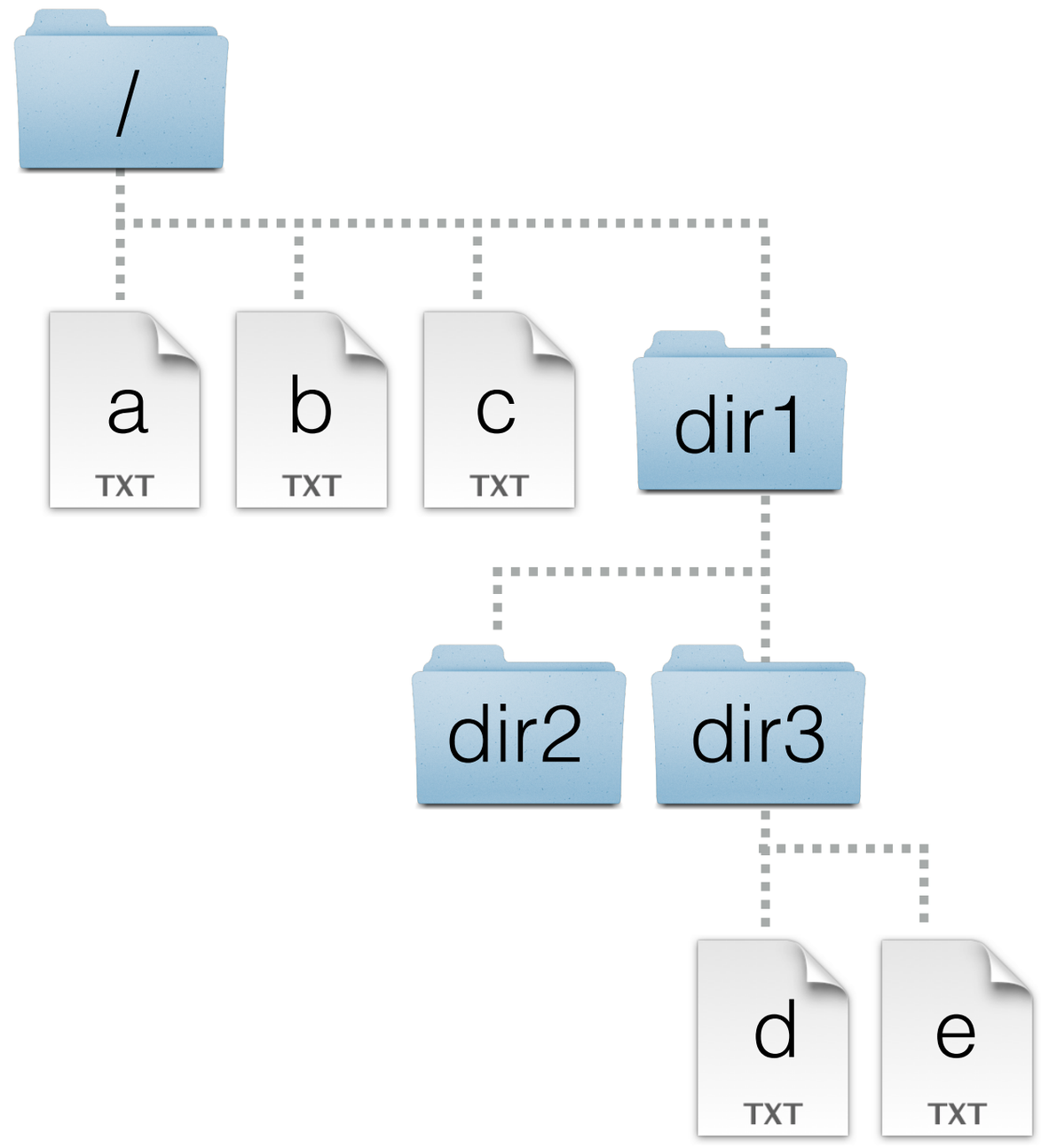
Hidden Files

- In Linux files can be hidden so they don't appear in a directory.
- Hidden files in Linux all begin with '**.**' character
- This is often used for configuration files, like **.vimrc**
- There are two special hidden files found in every directory.
- **.** - the current directory.
- **..** - the directory above this one in the hierarchy.



Relative File Paths

- Relative paths can be used to references files at other parts of the file system.
- This is useful as absolute paths can make a system inflexible or difficult to modify.
- For instance if we were presently working in **dir2** we could access fill '**e**' via: **../dir3/e**
- This can be interpreted as a set of actions:
  - go up one level (**..**)
  - enter **dir3**
  - access file '**e**'



Standard Filesystem Locations

- ***/etc*** - holds a lot of configuration files, e.g. /etc/cups controls the configuration of the printer queues and which devices are made available at boot.
- ***/dev*** - holds links to the various pieces of hardware being managed by the kernel
- ***/proc*** - holds views into the current kernel operating parameters and processes
- ***/var*** - holds 'variable' data, e.g. logging files, mail, printer spools
- ***/usr*** - holds binaries, documentation, software libraries
- ***/home*** - is the collection of private directories for users of the system
- ***/bin*** - contains the binaries that are essential to the system (shells, cp, mv, rm, cat, ls, etc…)
- ***/sbin*** - contains the binaries that are essential to the system but only for use by administrators

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Looking Around

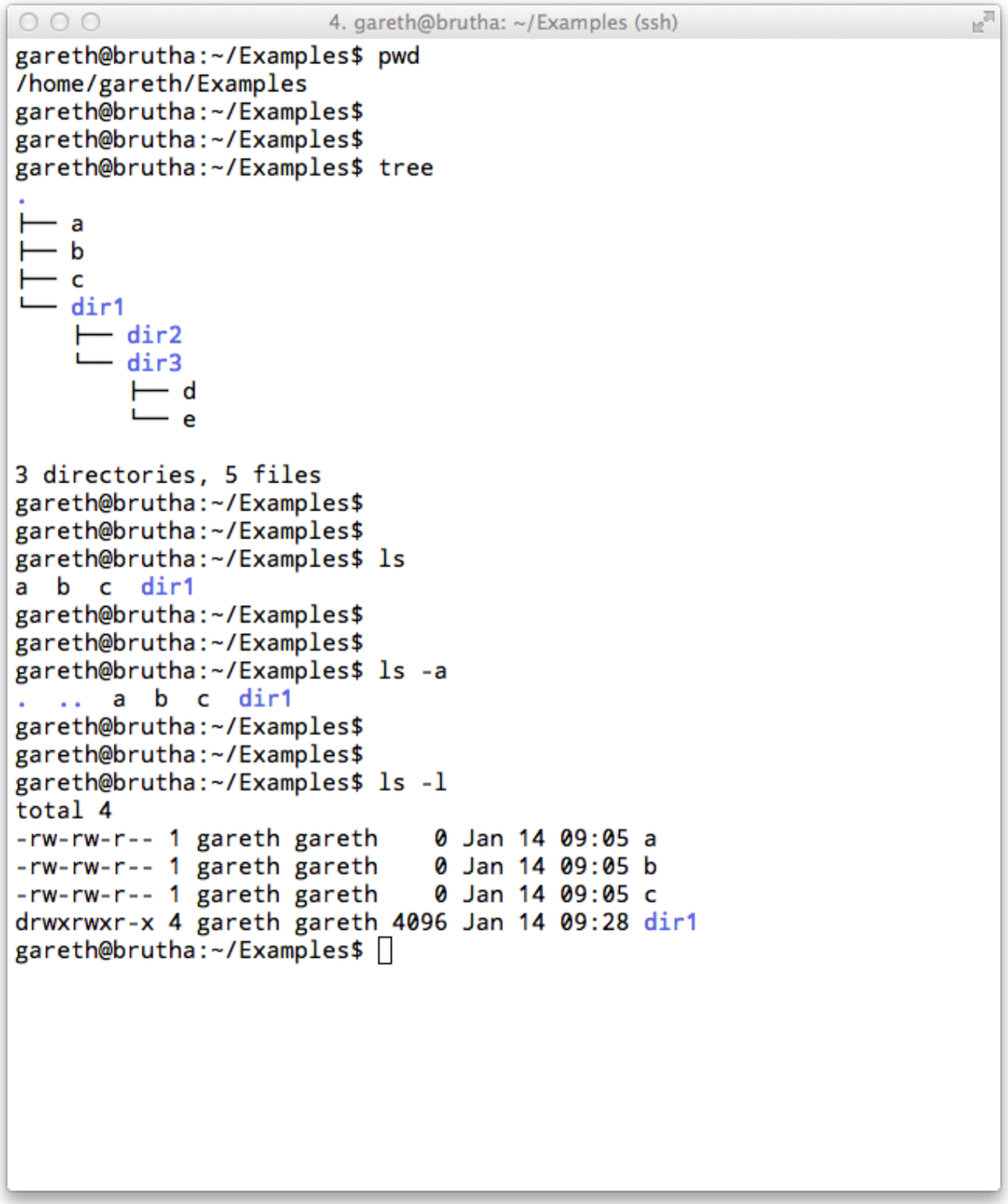
- **pwd** - tells us our current position in the filesystem (print working directory).

- **tree** - prints out the complete 'tree' of our current location, good for getting a visual representation of a directory.

- **ls** - lists the contents of a directory. By itself defaults to the current directory, but can be given an absolute or relative path.

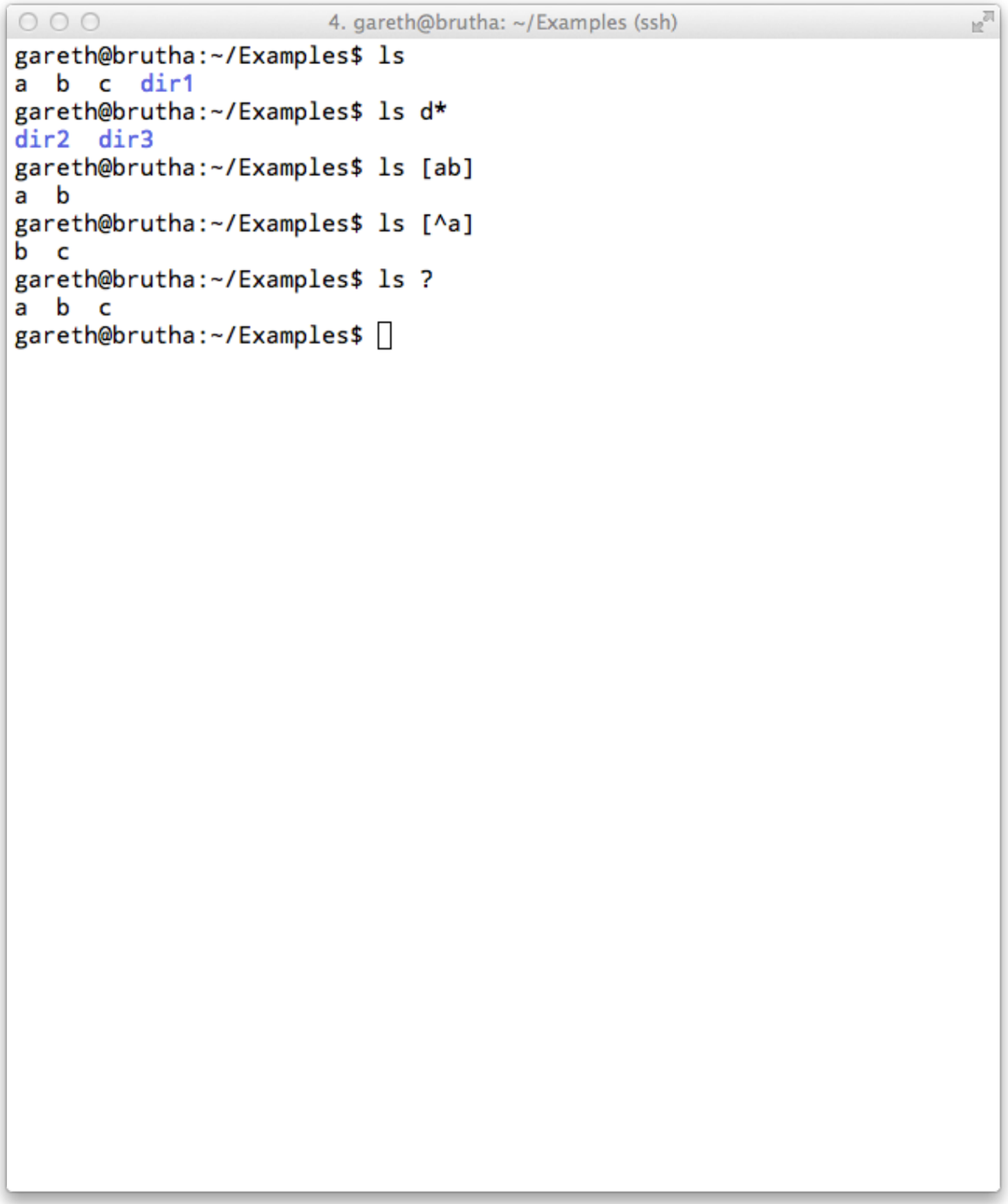
- **ls -a** - the minus a option tells ls to show hidden files.

- **ls -l** - the minus l option tells ls print the contents of a directory in long format.



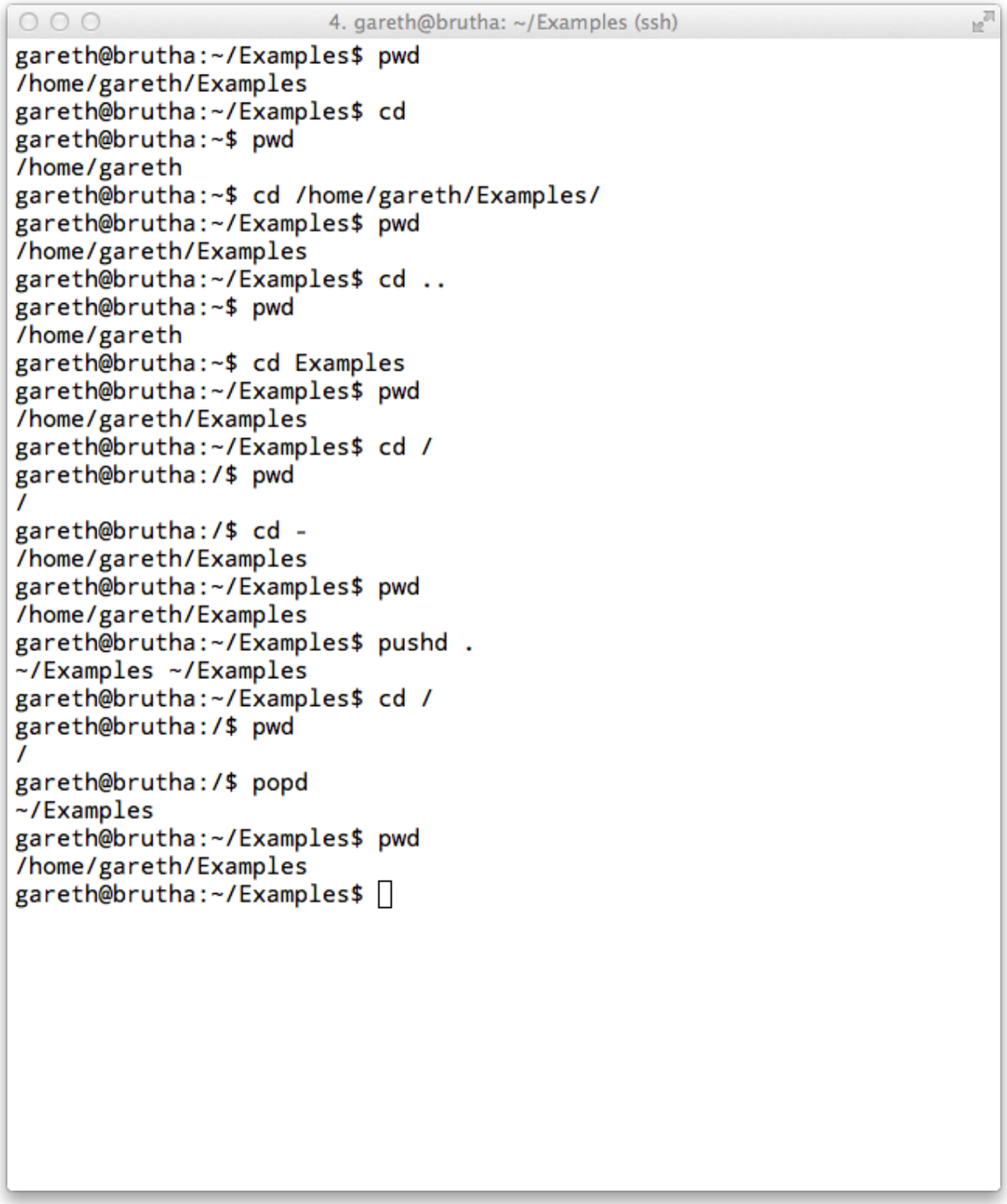
File Globbing

- **ls** can also be used to list specific files, and the list can be filtered by using wildcards.
- Wildcards are symbols that have special meanings when combined with filenames.
  - ***** - matches all characters
  - **?** - matches only one character.
  - **[]** - specifies alphanumeric values to match on i.e. [a-c]
  - **^** - negates a match
- For example we could match all the files that have a ‘txt’ extension by the following:
  - **ls *.txt**
- Or we could match on files whose name are only a single character
  - **ls ?**



Moving Around

- **cd** - command to “change directory”
- **cd** - with no arguments will return you to your home directory.
- **cd** <dir> - changes you to a directory <dir>. This can be an absolute or relative path.
- **cd -** - will return you to the previous directory.
- **pushd** - stores a directory path you’d like to visit later
- **popd** - takes the first directory stored and changes to it.



Finding Files

- **find** - used to search through the filesystem to find a file.
  - find ./ -name Lab04
  - find ./ -mtime +2
  - find ./ -mtime -3
- **locate** - accesses a database of files (usually built once a day), is faster than find but only as good as the database.
- Use find to get newer files, and if you want to filter on things like modification or creation time
- **whereis** - will return the location of programs and manages
  - whereis ls

```
4. gareth@brutha: ~/Examples (ssh)
gareth@brutha:~$ find ./ -name loop.*
./Lab04/loop.c
gareth@brutha:~$ find ./ -name loop*
./Lab04/loop2.c
./Lab04/loop.c
gareth@brutha:~$ cd Examples/
gareth@brutha:~/Examples$ find ./ -mtime -1
./
./b
./a
./dir1
./dir1/dir3
./dir1/dir3/d
./dir1/dir3/e
./dir1/dir2
./c
gareth@brutha:~/Examples$ locate loop.c
/home/gareth/Lab04/loop.c
/usr/lib/ocaml/toploop.cmi
/usr/share/doc/python2.7/examples/Demo/embed/loop.c
gareth@brutha:~/Examples$ whereis ls
ls: /bin/ls /usr/share/man/man1/ls.1.gz
gareth@brutha:~/Examples$
```

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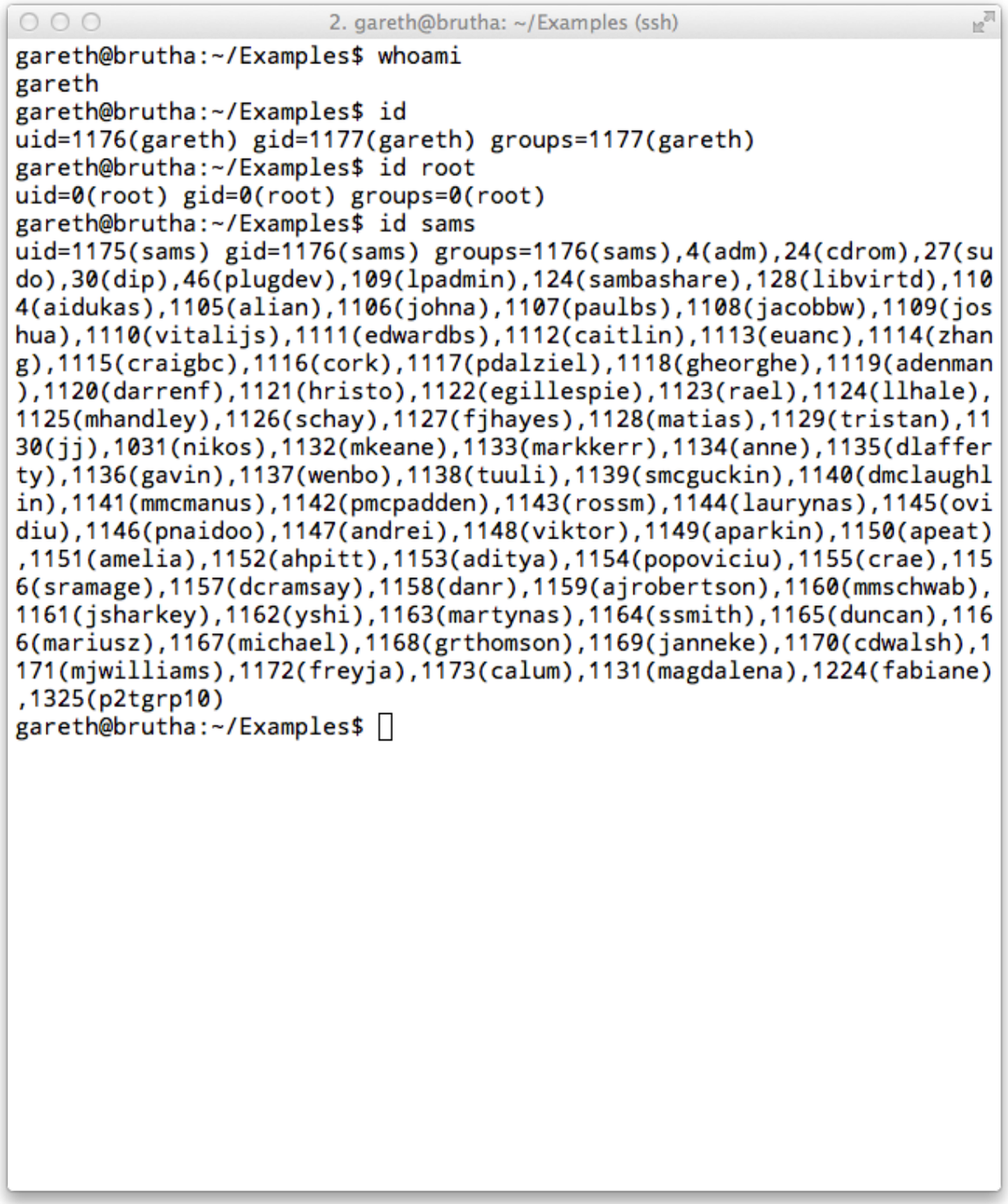
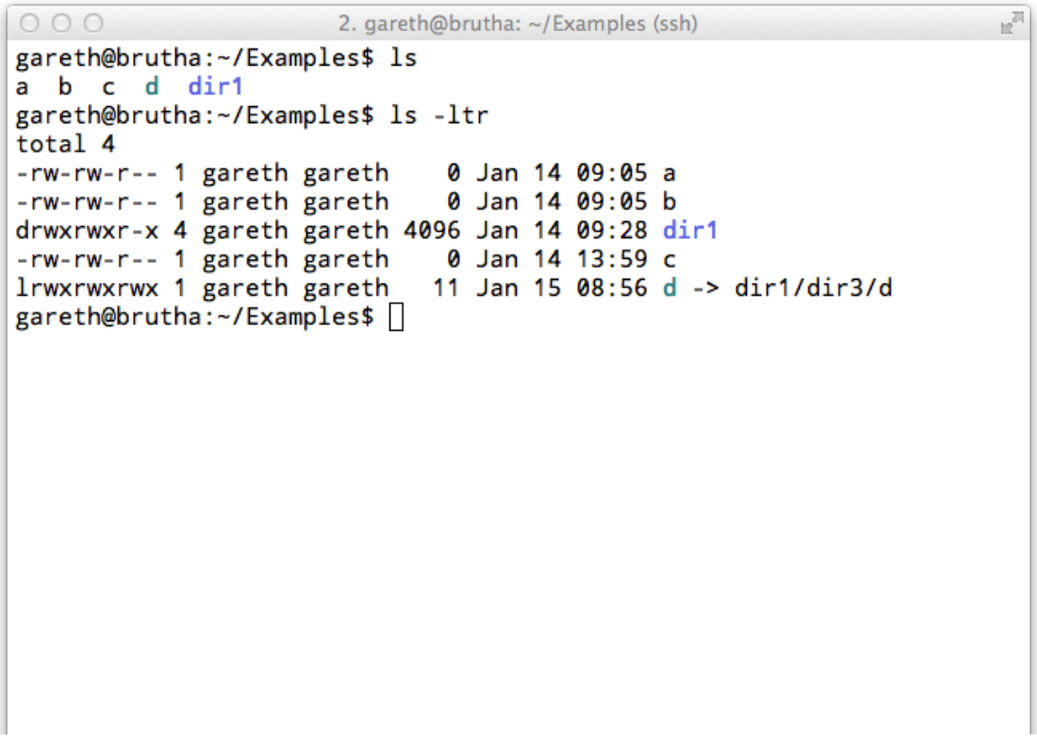
Users & Groups

- Linux is a multi-user operating system.
- Each User has a unique ID (**uid**) and is associated with a set of groups. Each group also has a unique id (**gid**)
- What a user can do is restricted by the rights associated with each user or group.
- **whoami** - tells you what your username is.
- **id** - tells you about your id and group info.
- Linux systems have the concept of a “root” (or super) user who can do anything on the system
- This right can also be delegated to a specific user, often referred to **sudoer** (super user do).



Permissions

- All restrictions in a Linux system are handled at the file level.
- Each file or directory has the notion of ownership by a user or by a group.
- Additionally restrictions are place on what can be done to a file.
- ls -l will show the contents of a directory in long format. This shows:
  - permissions
  - no. of links
  - owner
  - group owner
  - size of file in bytes
  - date modified
  - name




```
gareth@brutha:~/Examples$ ls -ltr
total 4
-rw-rw-r-- 1 gareth gareth    0 Jan 14 09:05 a
-rw-rw-r-- 1 gareth gareth    0 Jan 14 09:05 b
drwxrwxr-x 4 gareth gareth 4096 Jan 14 09:28 dir1
-rw-rw-r-- 1 gareth gareth    0 Jan 14 13:59 c
lrwxrwxrwx 1 gareth gareth   11 Jan 15 08:56 d -> dir1/dir3/d
```

Permissions

- First part is filetype
  - **d** - directory
  - **l** - link
  - **-** - normal file
- Next is permissions, split into three parts
  - **User** permissions
  - **Group** permissions
  - **Other** permissions (everyone on the system)
- Permissions are
  - **r** - read access
  - **w** - write access
  - **x** - execute

```
chmod [who][op][what] filename
```

- Can change permissions of a file using the **chmod** command
- who can be:
  - **u** - user permissions
  - **g** - group permissions
  - **o** - other permissions
  - **a** - all permissions
- op can be:
  - **+** - grant permissions
  - **-** - remove permissions
- what is one of the three permission types (**r,w,x**)

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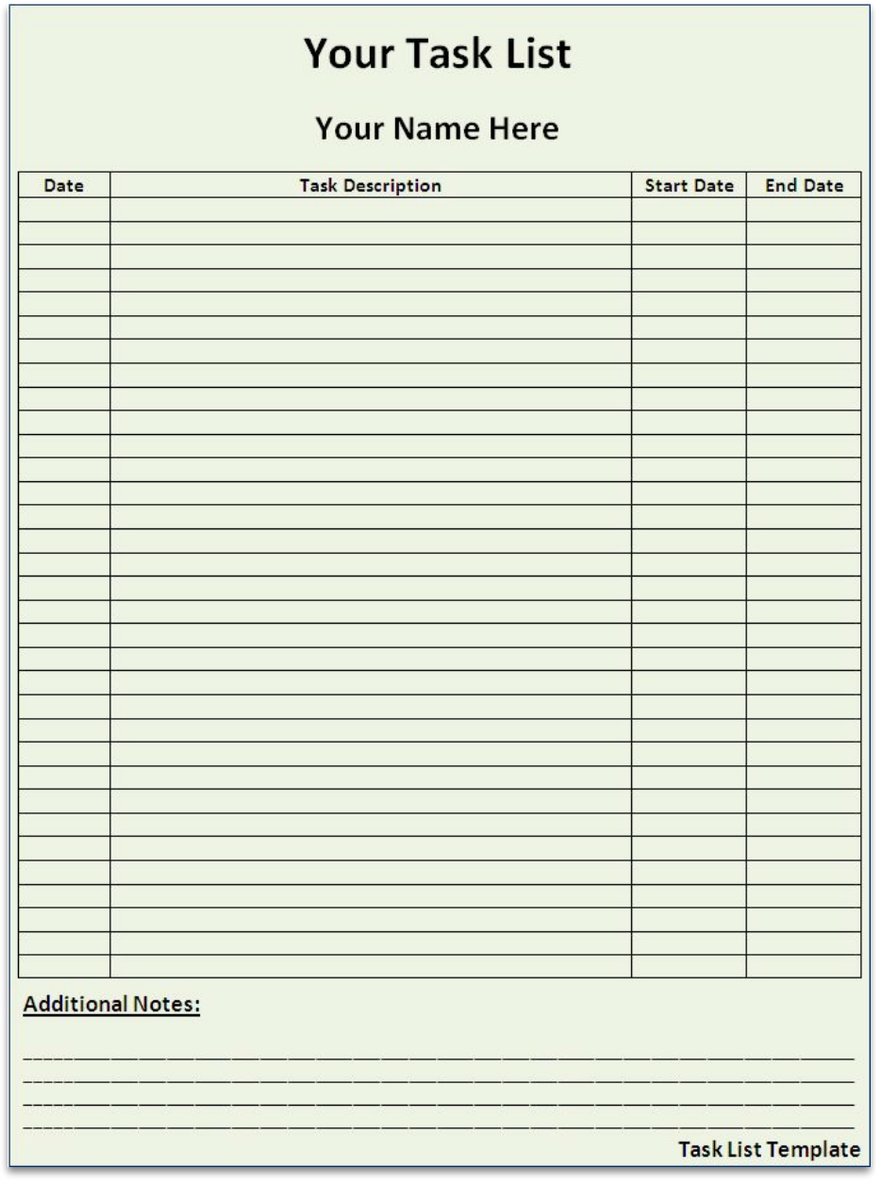
Common Tasks

- create a file or directory
- move a file or directory
- copy a file or directory
- deleting a file or directory
- look at the contents of a file
- look at the beginning of a file or end of a file
- find a line of text in a file



Your Task List

Your Name Here

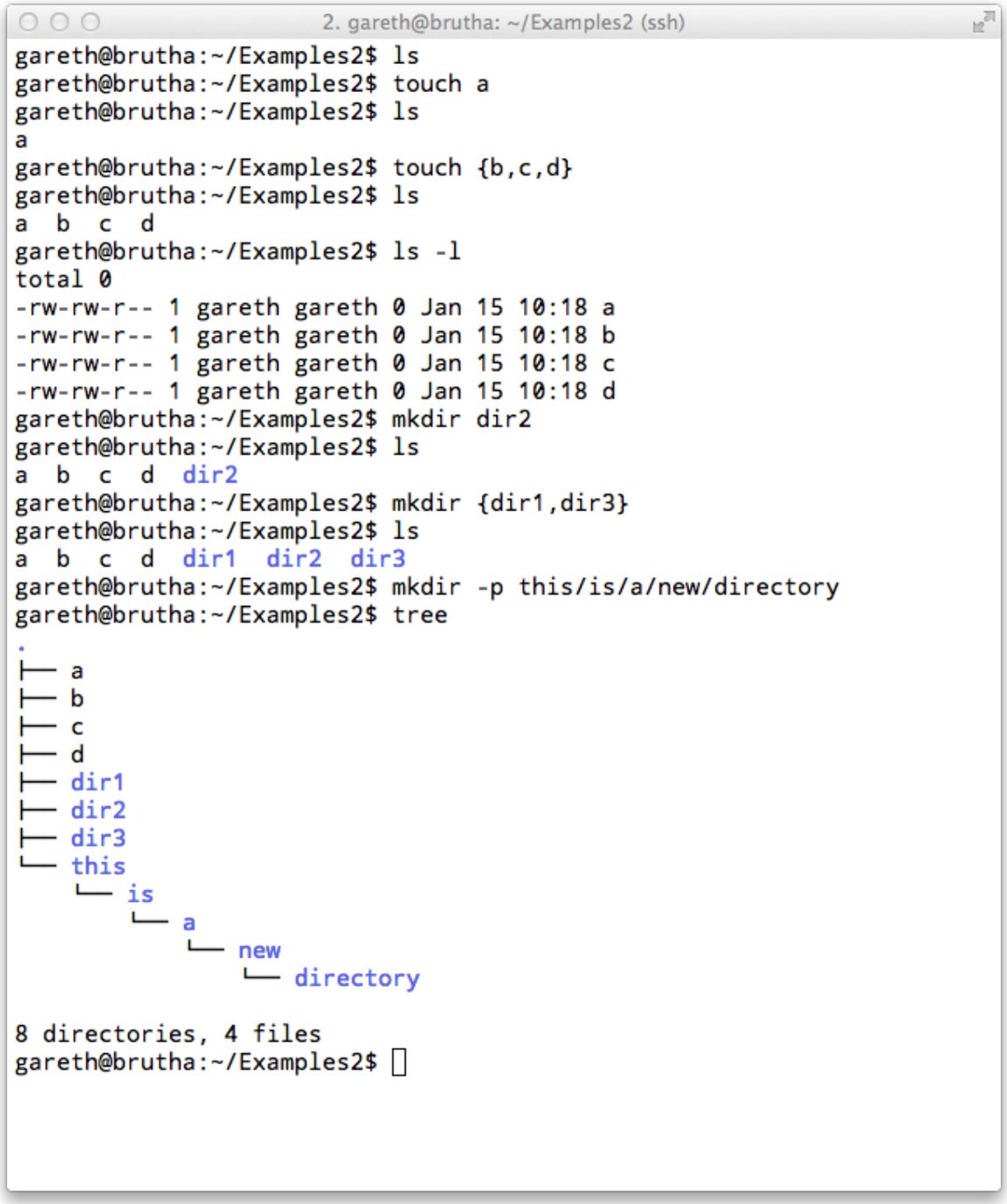
Date	Task Description	Start Date	End Date

Additional Notes:

Task List Template

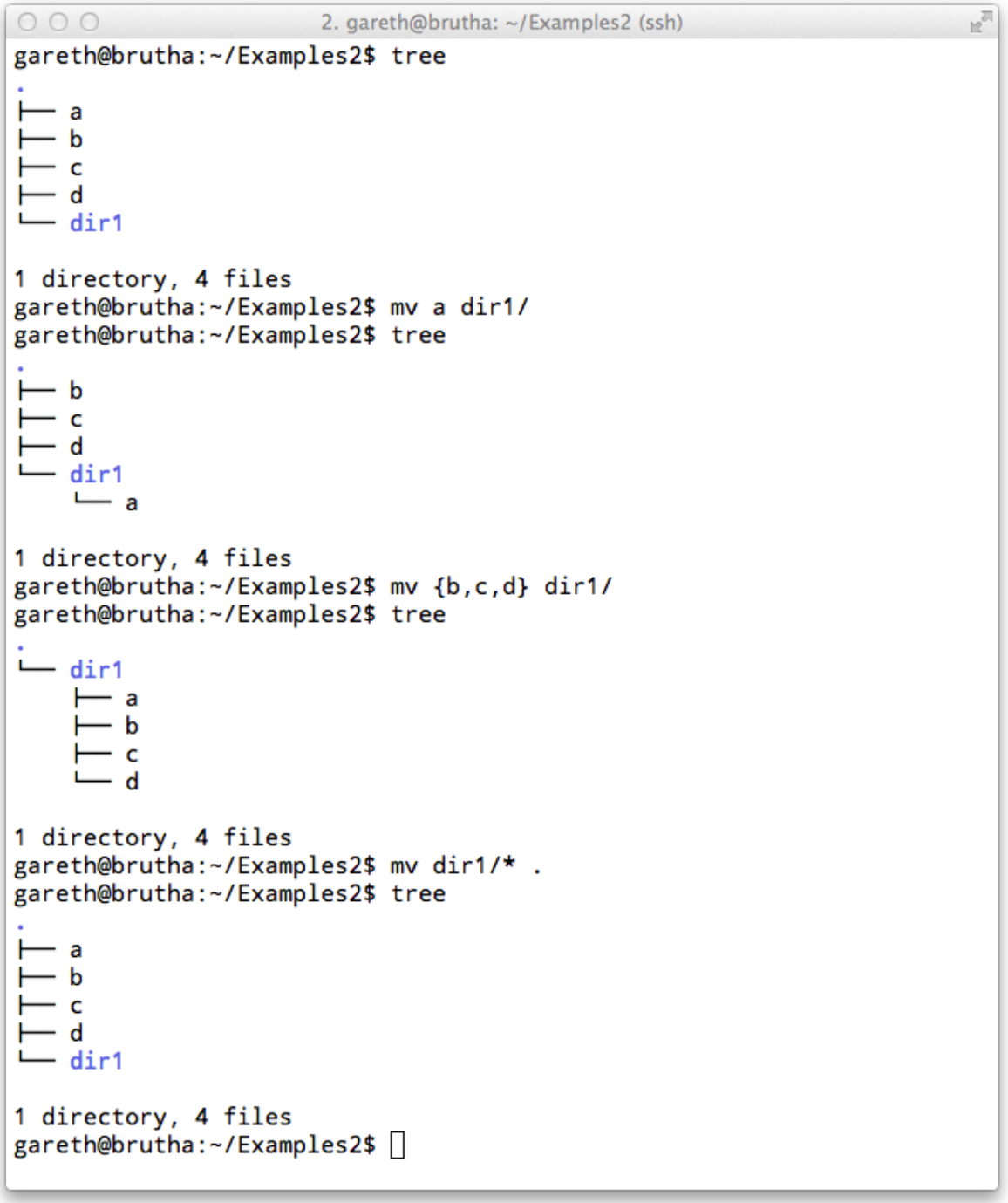
File Creation

- A file can be created using:
  - **touch** <filename>
- Multiple files can be created by giving a list:
  - **touch** {a,b,c}
- Directories are created using:
  - **mkdir** <filename>
- We can create multiple directories in the same was as files:
  - **mkdir** {dir1,dir2,dir3}
- We can create a set of nested directories using the **-p** option. This creates all the directories not present:
  - **mkdir -p** this/is/a/new/directory



Moving a File

- A file can moved by:
  - **mv** <src> <destination>
- Where <src> and <destination> can be either absolute or relative paths.
- Multiple files can be moved by giving a list:
  - **mv** {a,b,c,d} dir1
- Or by using a file glob:
  - **mv** dir1/* .
- The move command can also be used to rename a file:
  - **mv** a this_was_a



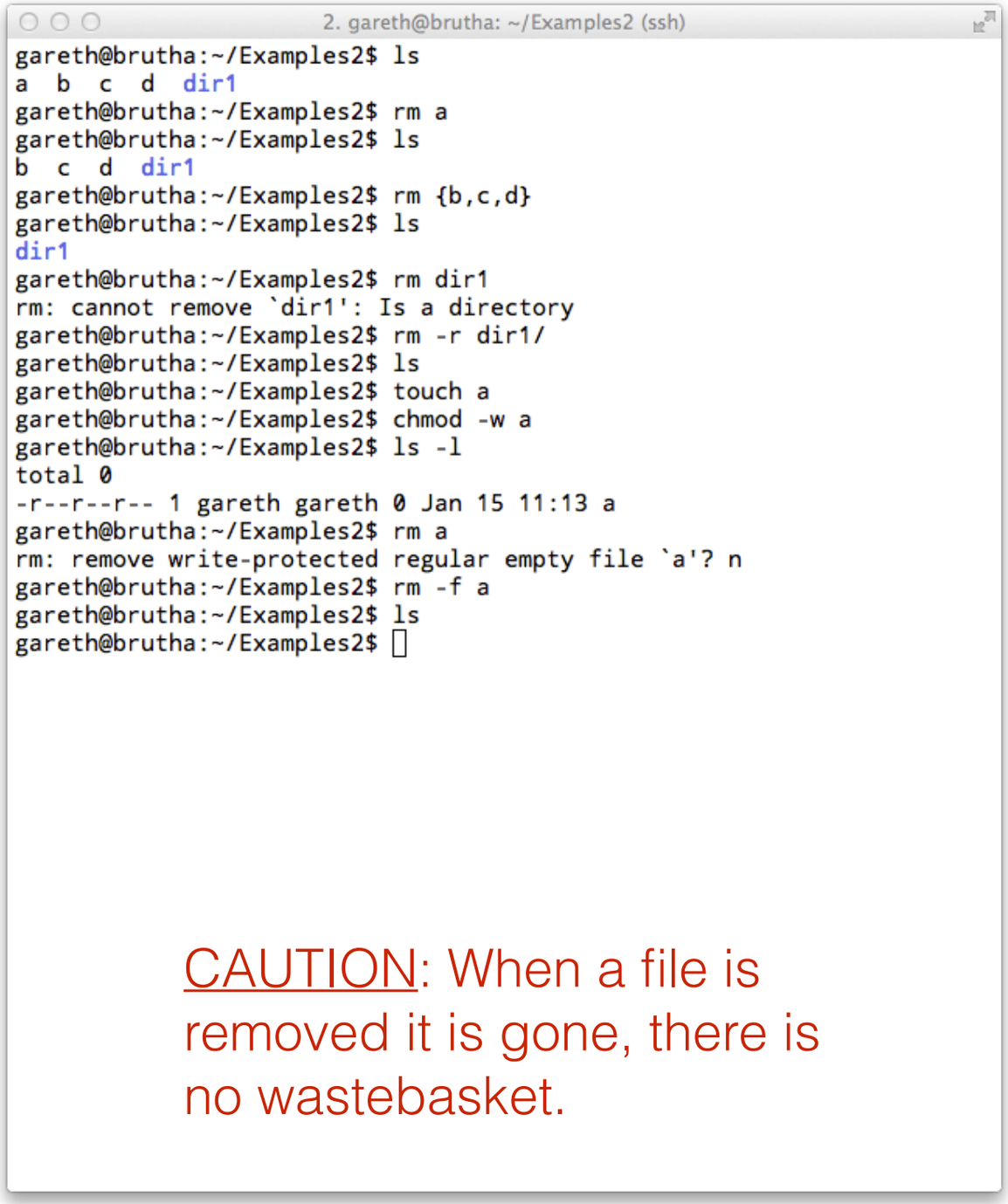
Copying a File

- A file can copied by:
  - **cp** <src> <destination>
- Where <src> and <destination> can be either absolute or relative paths.
- Multiple files can be copied by giving a list or a glob:
  - **cp** {a,b,c,d} dir1
  - **cp** dir1/* .
- Copying directories is a little different, you need to tell copy that you want to recursively copy all the files, so:
  - **cp -r** dir1 dir2

```
2. gareth@brutha: ~/Examples2 (ssh)
.
├── a
├── b
└── dir1

1 directory, 2 files
gareth@brutha:~/Examples2$ cp a dir1/
gareth@brutha:~/Examples2$ tree
.
├── a
├── b
└── dir1
    └── a

1 directory, 3 files
gareth@brutha:~/Examples2$ cp {a,b} dir1/
gareth@brutha:~/Examples2$ tree
.
├── a
├── b
└── dir1
    ├── a
    └── b

1 directory, 4 files
gareth@brutha:~/Examples2$ cp dir1 dir2
cp: omitting directory `dir1'
gareth@brutha:~/Examples2$ cp -r dir1 dir2
gareth@brutha:~/Examples2$ tree
.
├── a
├── b
├── dir1
│   ├── a
│   └── b
└── dir2
    ├── a
    └── b

2 directories, 6 files
gareth@brutha:~/Examples2$
```

Deleting a File

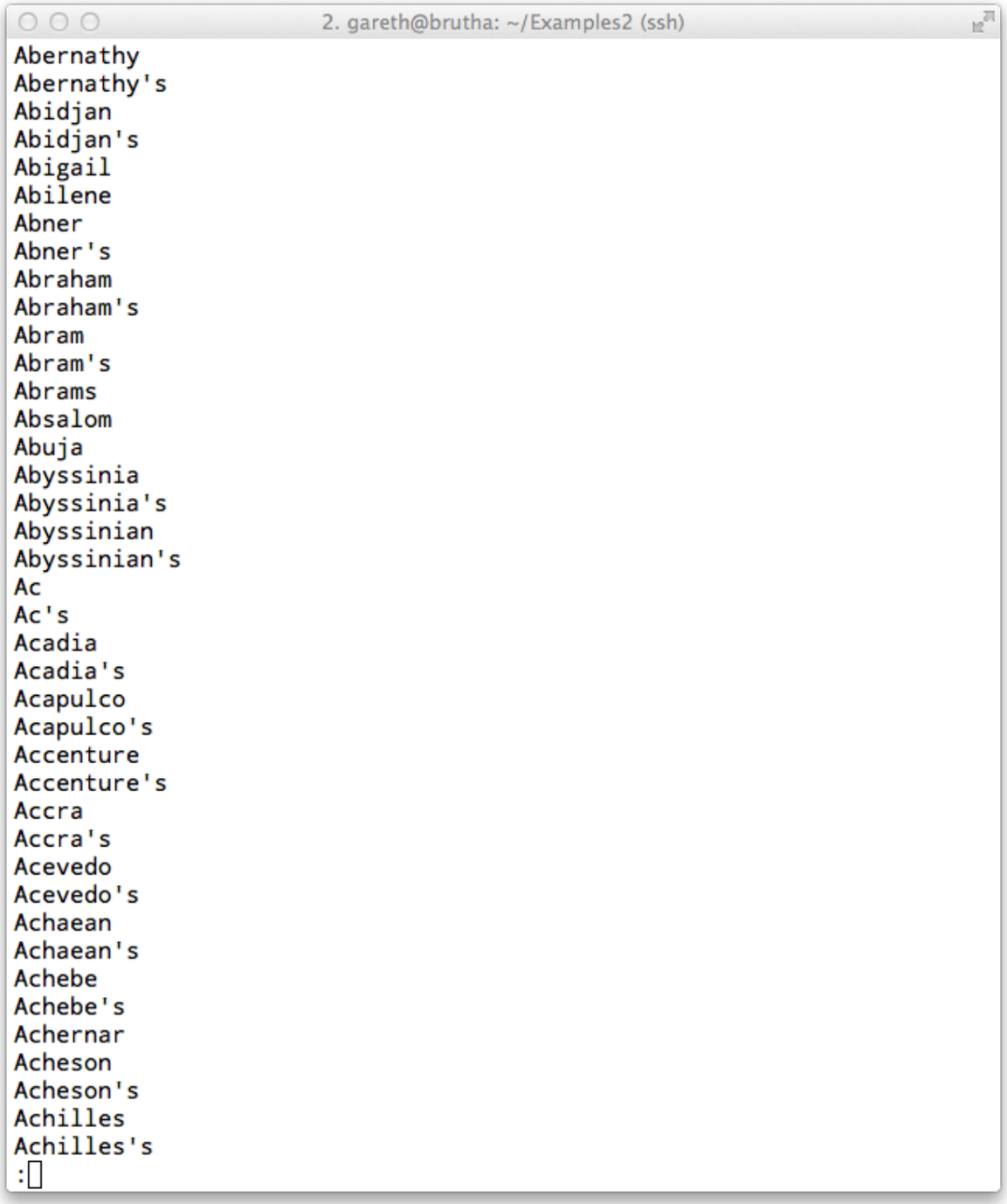
- A file can deleted or removed by:
  - **rm** <filename>
- Where <filename> can be either an absolute or relative path.
- Multiple files can be removed by giving a list or a glob:
  - **rm** {a,b,c,d}
  - **rm** dir1/*
- Like copying removing directories is a little different, you need to tell rm that you want to recursively delete all the files, so:
  - **rm -r** dir1
- Some files are also write protected (-r--r--r--) and you may have to remove with force:
  - **rm -f** <filename>
  - **rm -rf** dir1



CAUTION: When a file is removed it is gone, there is no wastebasket.

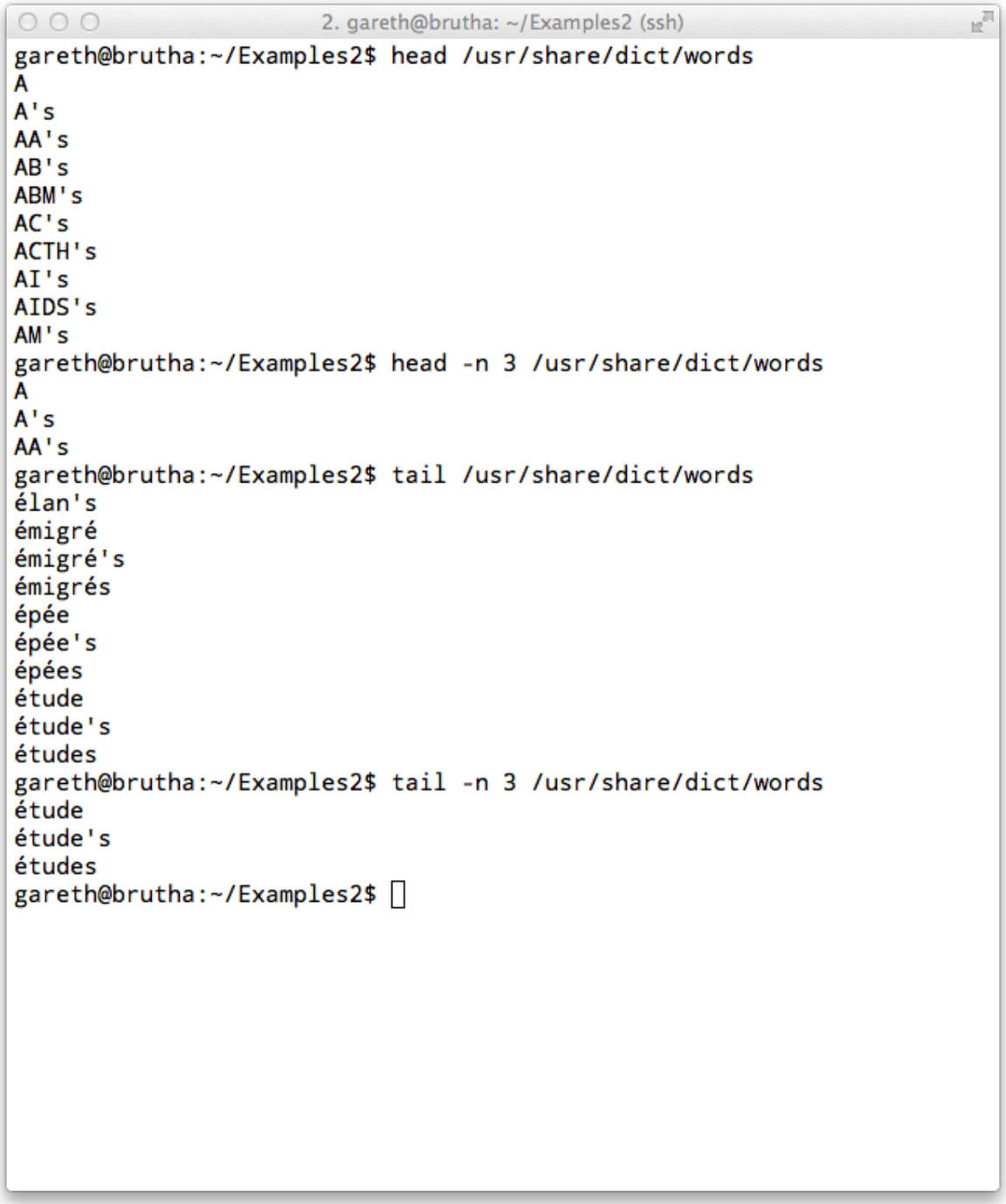
Looking at Files

- They type of file can be found by using:
  - **file** <filename>
- The contents of file can be written to the terminal by using:
  - **cat** <filename>
- cat shows the whole contents of the file, we can see one page at a time using less or more:
  - **less** <filename>
  - **more** <filename>
- Of note, more will load the whole file into memory while less will only access the amount it needs to display.



Looking at bits of files

- For very large files (especially things like log file) you may only want to look at the start or end of the file.
- We can do this by using:
  - **head** <filename>
- This will print out the first ten lines of a file. If we want to print more or less than that we can specify, so:
  - **head -n 3** <filename>
- As with head, we can also look at the end of a file with tail:
  - **tail** <filename>
  - **tail -n 3** <filename>
- Tail can also be used to watch the end of a file and print out anything that is appended. This can be useful for watching things like logs:
  - **tail -f** <filename>



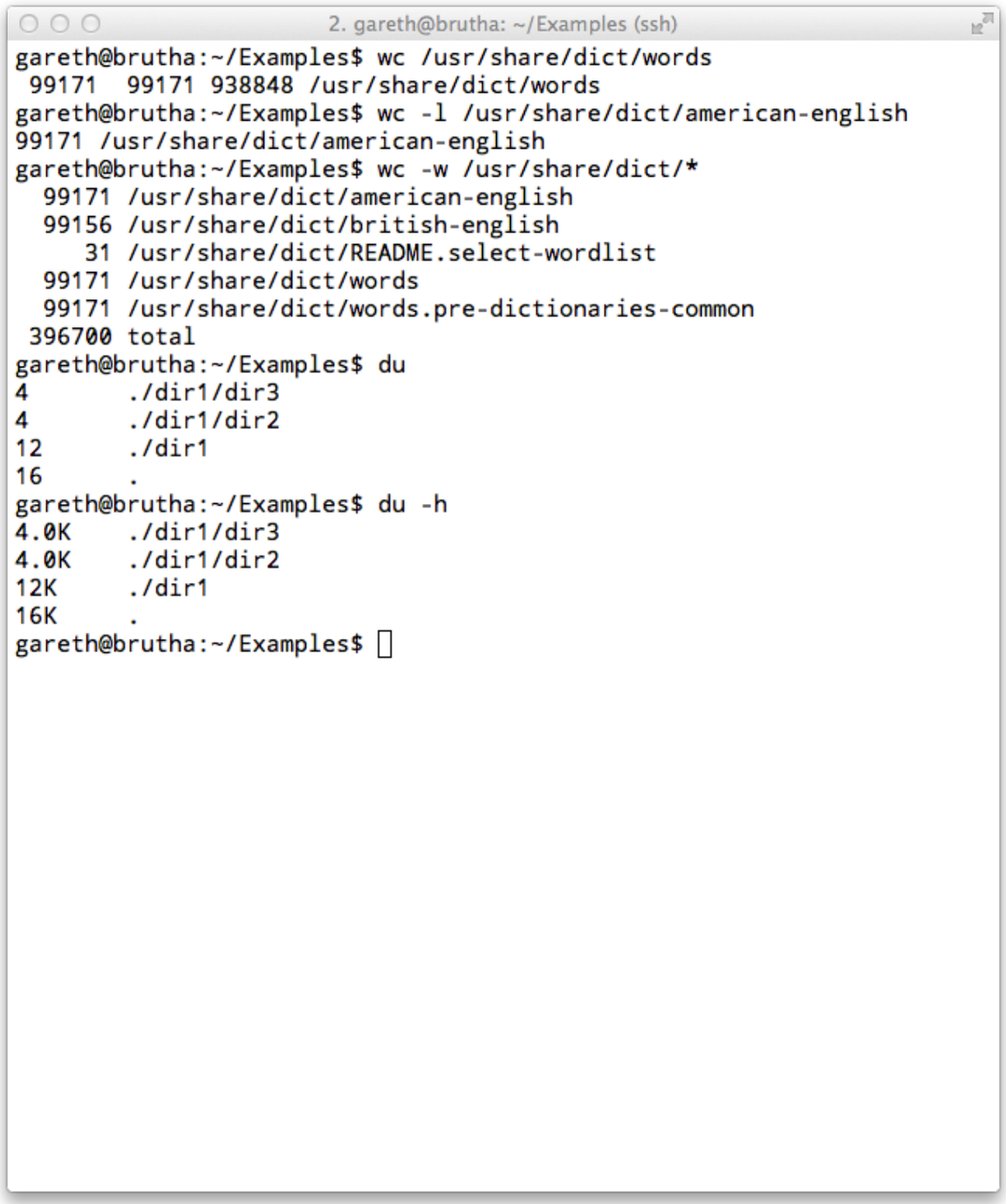
Searching in a File

- Often you'd like to search for a particular word or phrase in a text file (or a particular variable name in a piece of C code).
- We can do this by using the grep command:
  - **grep** <expression> <filename>
- grep takes something called a "regular expression" and searches for it through a file.
- To search for the word "sum" in a C program called loop.c, we would write
  - **grep** "sum" loop.c
- You can get the line numbers for each line that matches by using the -n option:
  - **grep** -n "sum" loop.c
- You can search for more complicated things by using patterns:
  - * - match 0 to as many of the preceding character
  - . - match exactly one character
  - [a-z] - match any lowercase character
  - [0-9] - match any digit
  - ^ - match the start of the line
  - $ - match the end of the line

```
2. gareth@brutha: ~/Examples2 (ssh)
gareth@brutha:~/Examples2$ grep sum loop2.c
    int sum;
    sum = stats(argc-1, data, acc);
    printf("\nSum - %d\n\n",sum);
   int sum = 0;
       sum = sum + data[i];
   average = sum /length;
   return sum;
gareth@brutha:~/Examples2$ grep -n sum loop2.c
16:    int sum;
33:    sum = stats(argc-1, data, acc);
35:    printf("\nSum - %d\n\n",sum);
48:   int sum = 0;
53:       sum = sum + data[i];
58:   average = sum /length;
63:   return sum;
gareth@brutha:~/Examples2$ grep "su." loop2.c
int stats(int length, int *data, int *result);
    int sum;
    sum = stats(argc-1, data, acc);
    printf("\nSum - %d\n\n",sum);
int stats(int length, int *data, int *result) {
   int sum = 0;
       sum = sum + data[i];
   average = sum /length;
   result[0] = average;
   result[1] = max;
   result[2] = min;
   return sum;
gareth@brutha:~/Examples2$ grep "^\s*sum" loop2.c
    sum = stats(argc-1, data, acc);
       sum = sum + data[i];
gareth@brutha:~/Examples2$
```

Other Useful Commands

- Sometimes you want to find out how many words to lines are in a file. To do this use wc:
  - **wc** <filename>
  - **wc -l** <filename> (for lines)
  - **wc -w** <filename> (for words)



- You can sort the contents of a file using the sort command:
  - **sort** <filename>
- If you want to find out how much storage your files are taking up you can do:
  - **du** <directory>
  - **du -h** <directory>

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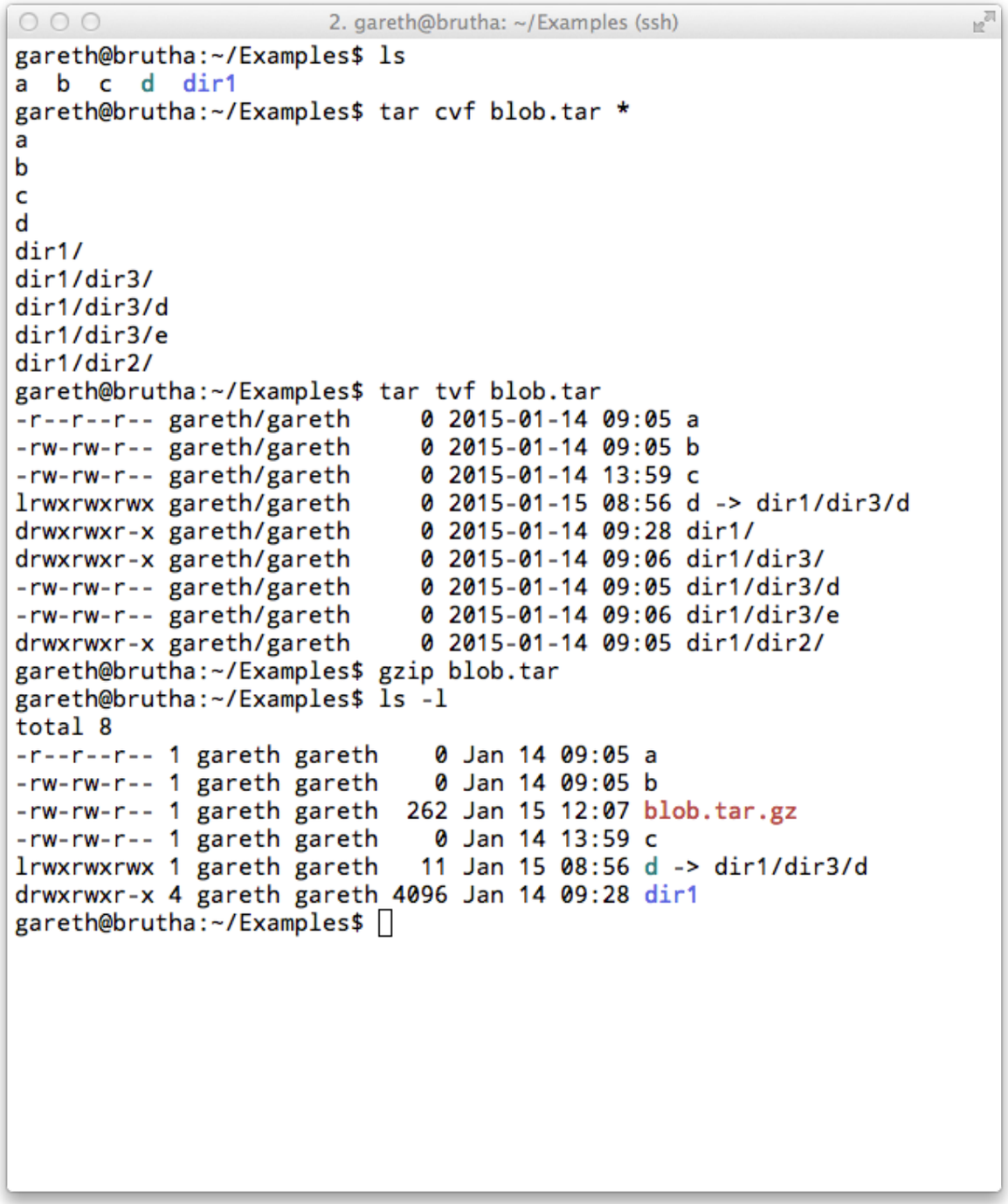
Tarballs

- Sometimes you'd like to package up all your files in a single file.
- Similar to zipping or raring a file on Windows or OS X
- On Linux the default way for doing this is to create a "tarball"
- **tar** (tape archive) is a tool that was used for writing files to tape.
- It can be used to put all the files in a directory tree into a single file and preserve the paths.
  - **tar** cvf <filename> <files>
  - **tar** tvf <filename>
  - **tar** xvf <filename>
- You may also want to compress the archive, which can be done via tar or using gzip:
  - **tar** zcvf <filename> <files>
  - **gzip** blob.tar



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