ALLEGHENY COLLEGE

Operating Systems:
Chapter 4
Basic file systems

CS400

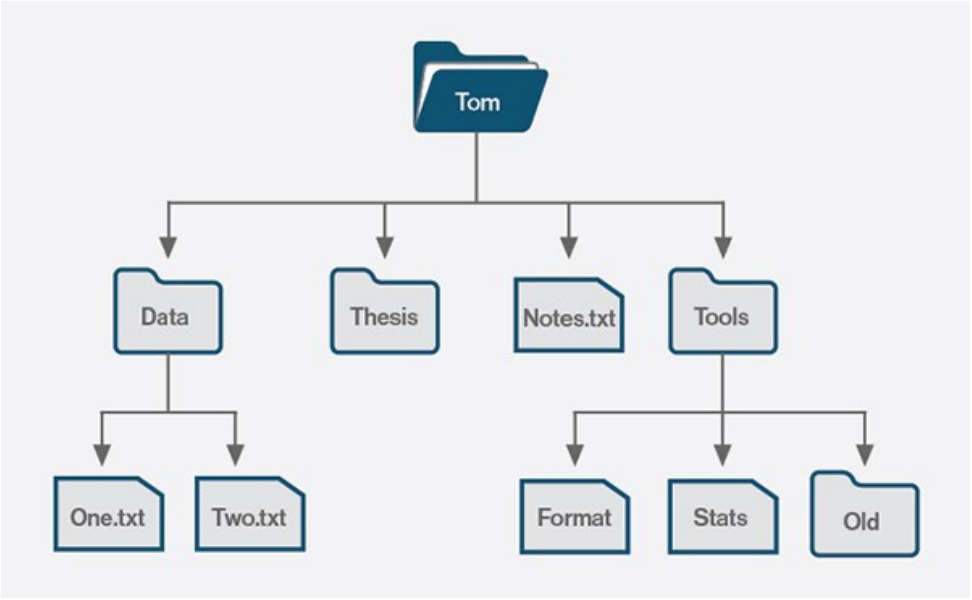
Week 6: 11th Feb

Spring 2020

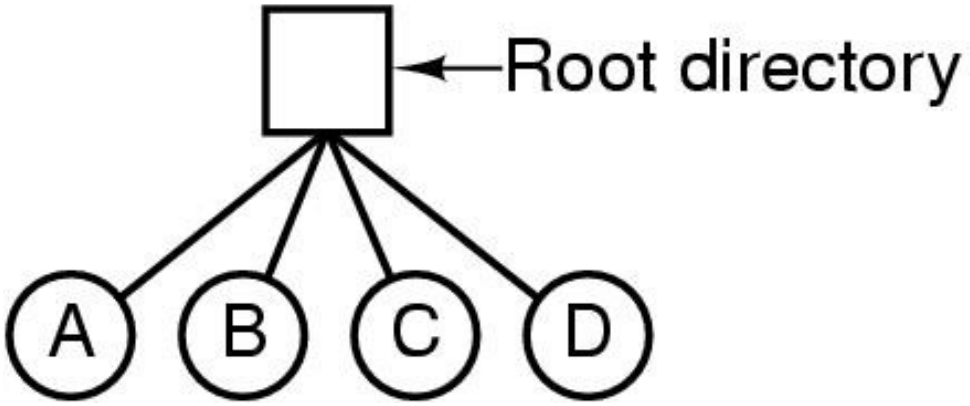
Oliver BONHAM-CARTER

Directory Systems

- A conventional organized arrangement of files and directories according to an operating
- A system that is used to control how data is stored and retrieved.
- Without a file system, information placed in a storage medium would be one large body of data with no way to tell where one piece of information stops and the next begins.

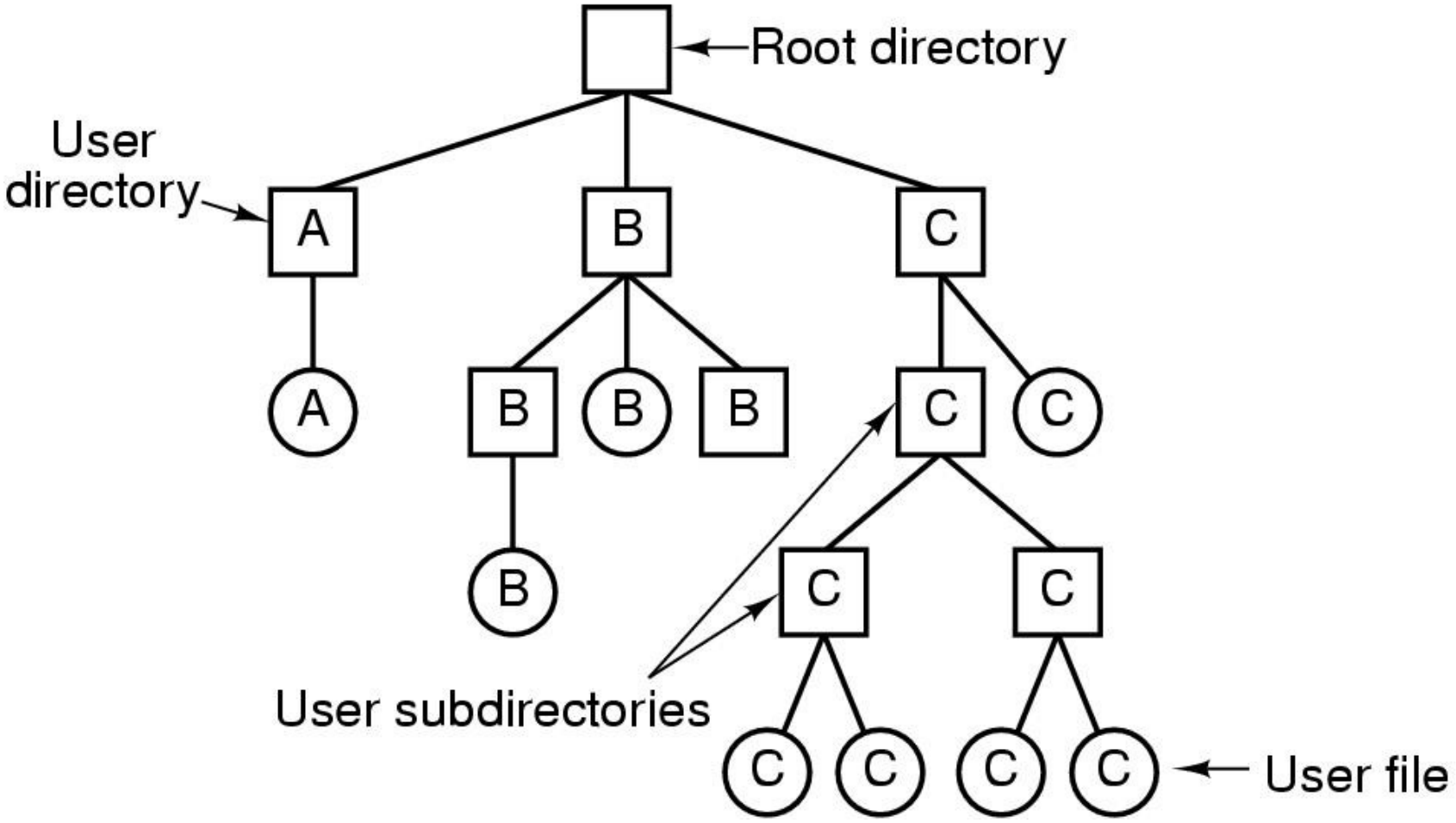


Single Level Directory Systems

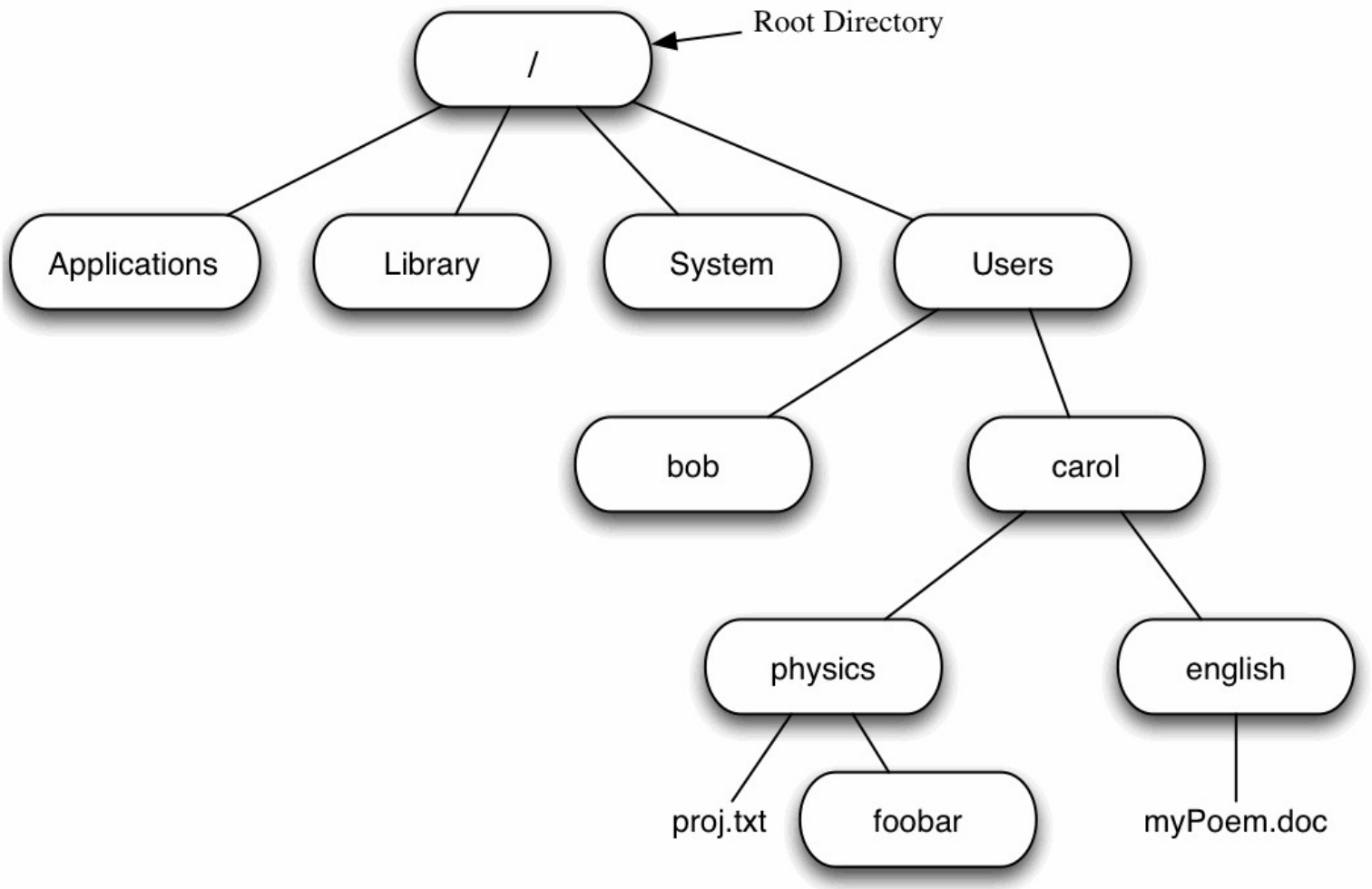


A single-level directory system containing four files.

Hierarchical Directory Systems



Directories Store Files



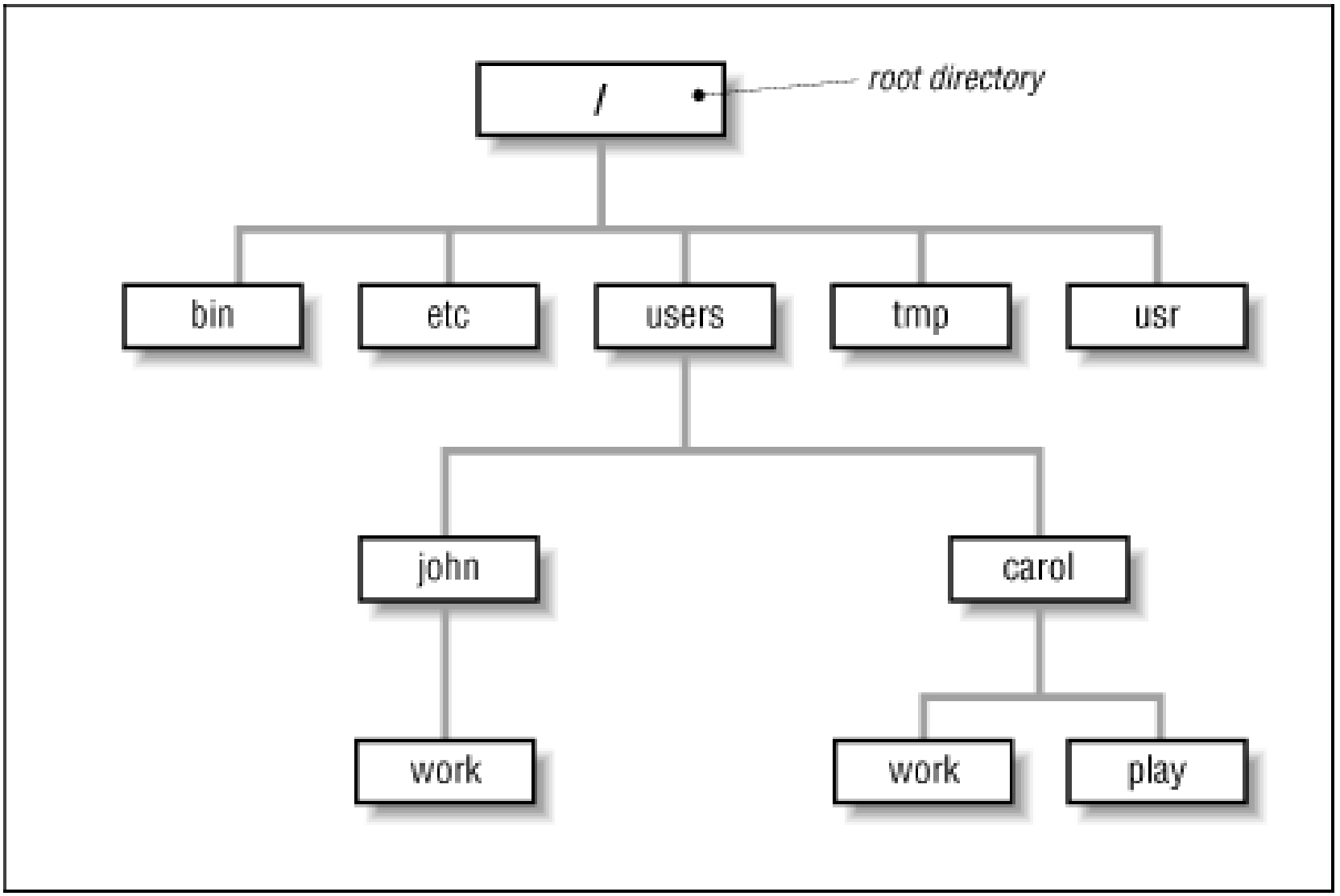
- Information (as stored in files) may be placed in special places: directories

OS Type-Specific Systems

- Each OS has own organization (Unix, Linux, MacOS, Windows, etc.)

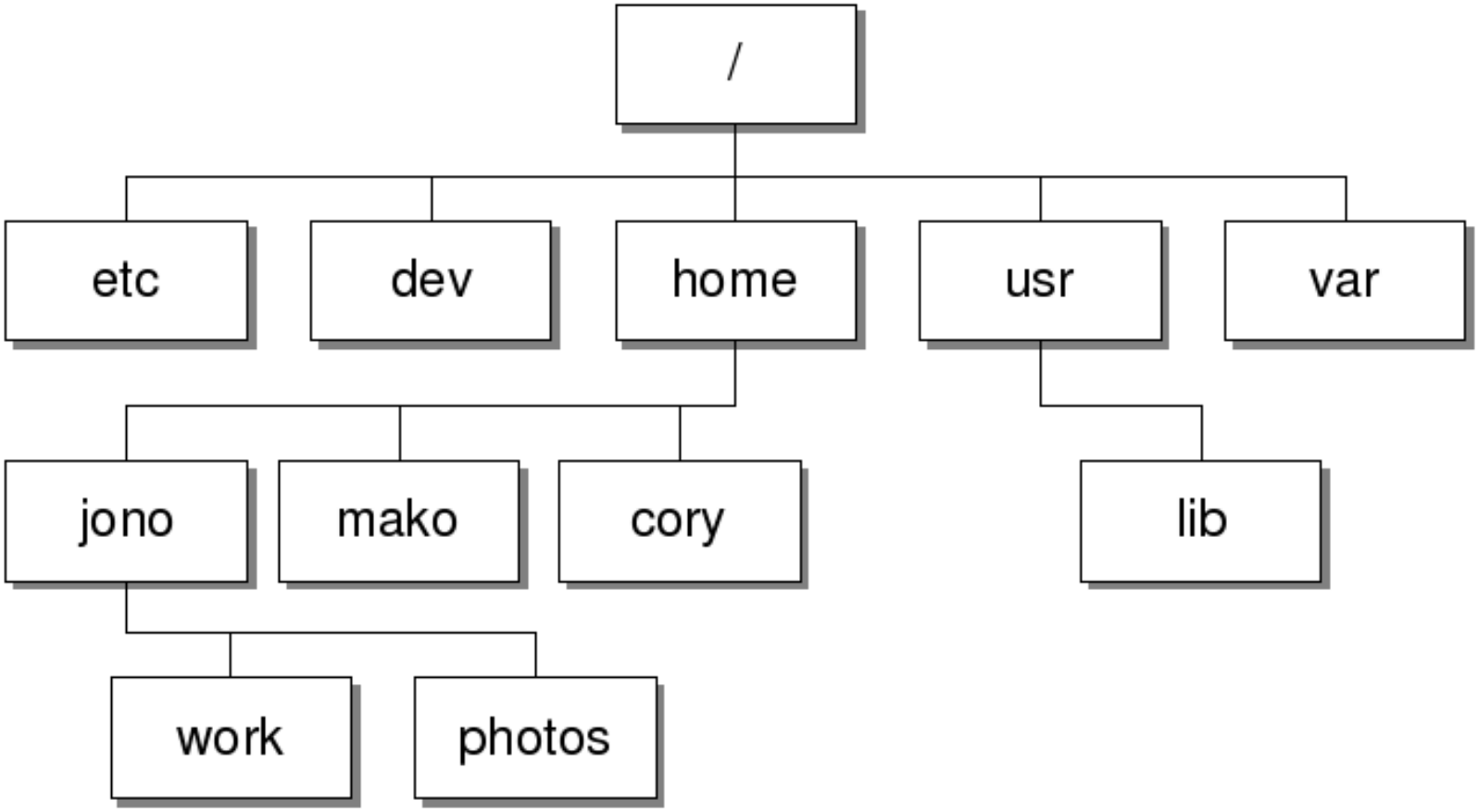
ALLEGHENY COLLEGE

Unix Directory Tree



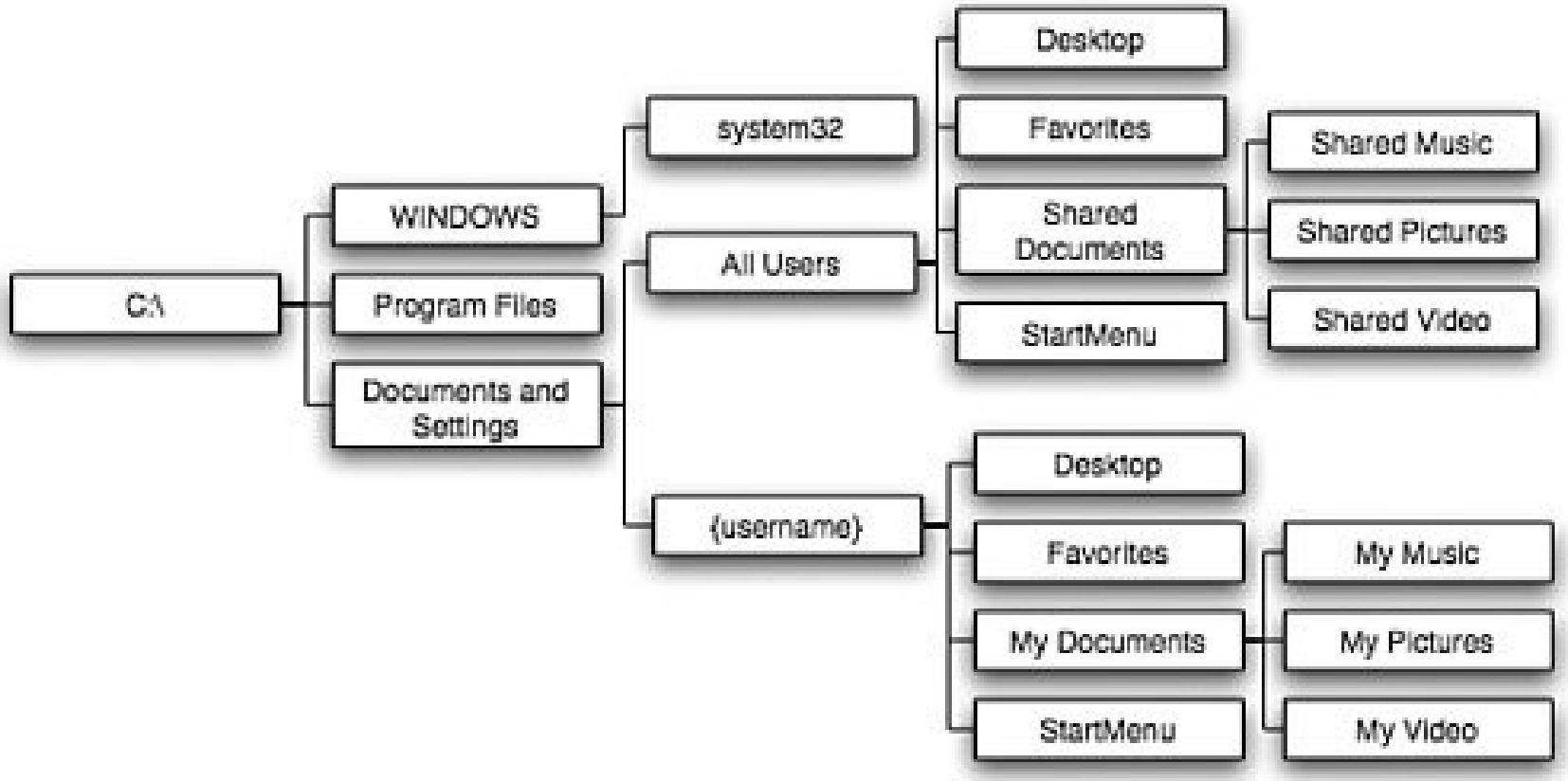
ALLEGHENY COLLEGE

Linux Directory Tree



ALLEGHENY COLLEGE

Windows Directory Tree



ALLEGHENY COLLEGE

Differences Between OSs

- Many different directories for same types of files
- User data is stored in:
  - Linux: /home/userName
  - Windows: DocumentsAndSettings/usrName
  - Mac: /Users/userName
- **Why could this become a programming nightmare when developing software to run on both types of OS?**

ALLEGHENY COLLEGE

Notable Linux Directories (1)

- *pwd* – command to determine the current directory
  - Parents: above where you are, children: below your current directory
- /home : specific user's working dir
- root: top of the file chain, no parent directory.
- /root: home directory for the super-user
- /usr: system software, documentation, source (biggest directory in file system)
- /dev: hardware profiles for installed components
- /var: *variables* directory changing data (system logs, DBs)

ALLEGHENY COLLEGE

Notable Linux Directories (2)

- /etc: config files, text files for booting and other system procedures
- /mnt: hard drives, flash drives, etc
- /lost+found: recovered files after kernel panics or system crashes
- /tmp: temporary files are placed here. After reboot, these files are magically erased.
- /bin: executable programs and commands
- /opt: programs which are not default installs

ALLEGHENY COLLEGE

Files Systems

- A file system consists of files, relationships to other files, as well as the attributes of each file.
- File attributes are information relating to the file, but do not include the file's data contained within a file.
- File attributes for a generic operating system might include (but are not limited to):
  - a file type (i.e. what kind of data is in the file)
  - a file name (which may or may not include an extension)
  - a physical file size
  - a file owner
  - file protection/privacy capability
  - file time stamp (time and date created/modified)

ALLEGHENY COLLEGE

Files Systems: Working Directory

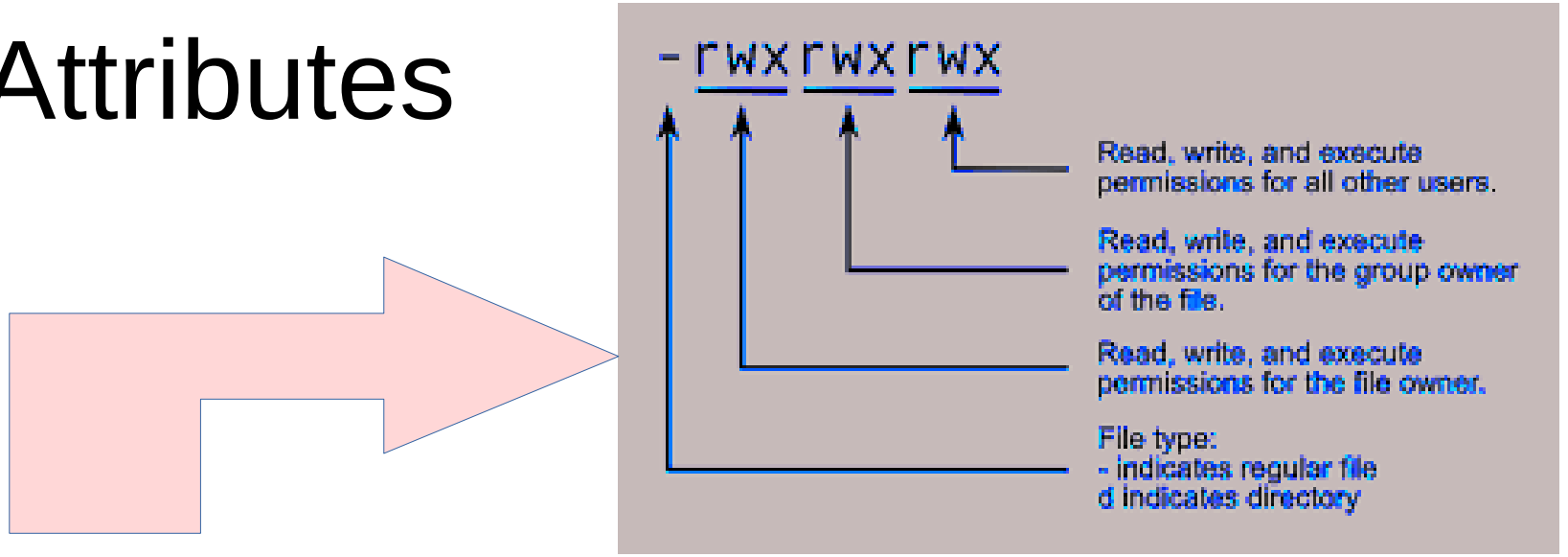
- Find current the path (print working directory): pwd

```
$ pwd
    /home/obonhamcarter
```

Note: the parent of this directory is:

```
    /home       # in absolute form
    ..          # in relative form
```

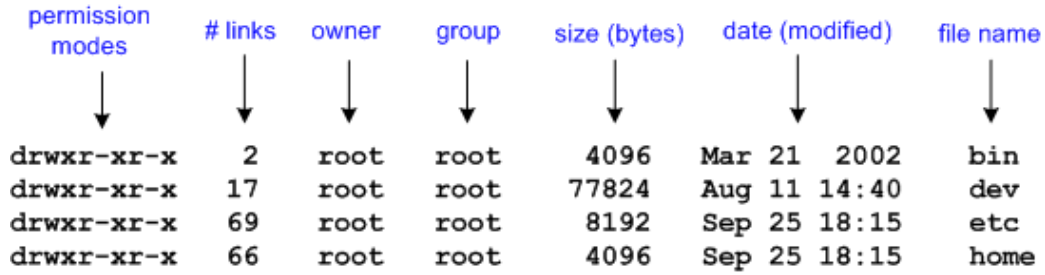
Attributes



permission modes	# links	owner	group	size (bytes)	date (modified)	file name
drwxr-xr-x	2	root	root	4096	Mar 21 2002	bin
drwxr-xr-x	17	root	root	77824	Aug 11 14:40	dev
drwxr-xr-x	69	root	root	8192	Sep 25 18:15	etc
drwxr-xr-x	66	root	root	4096	Sep 25 18:15	home
dr-xr-xr-x	46	root	root	0	Aug 11 10:39	proc
drwxr-x---	12	root	root	4096	Aug 7 2002	root
drwxr-xr-x	2	root	root	8192	Mar 21 2002	sbin
drwxrwxrwx	6	root	root	4096	Sep 29 04:02	tmp
drwxr-xr-x	16	root	root	4096	Mar 21 2002	usr
-rw-r--r--	1	root	root	802068	Sep 6 2001	vmlinuz

Attributes: Definitions

- **File name**: the associated name (file or directory).
- **Modification date**: the date the file was last modified; a "time-stamp." Note: If the file has not been modified within the last year (or six months for Linux), the year of last modification is displayed.
- **Size**: The size of the file in bytes
- **Group**: The associated group for the file
- **Owner**: The owner of the file
- **Number of links**: The number of other links associated with this file
- **Permission modes**: The permissions assigned to the file for the owner, the group and all others.



ALLEGHENY COLLEGE

Files in Linux: Attributes

- List file attributes on a Linux second extended file system
- Lsattr

```
----------e----- ./memShow.c
----------e----- ./optimizer.java
----------e----- ./DiskAnalysis.c
----------e----- ./data.dat
```

- e - ***extent format***: indicates the file is using extents for mapping the blocks on disk.

- Lists the file attributes on a second extended file system: man lsattr
- Manipulate attributes: man chattr
- Change the file mode: chmod

a - append only

c - compressed

d - no dump

e - extent format

i - immutable

j - data journaling

s - secure deletion

t - no tail-merging

u - undeletable

A - no atime updates

D - synchronous directory updates

S - synchronous updates

T - top of directory hierarchy

Files are Information Delimiters

- By separating the data into pieces and giving each piece a name, the information is easily isolated and identified.
- Taking its name from the way paper-based information systems are named, each group of data is called a "file".

File Types

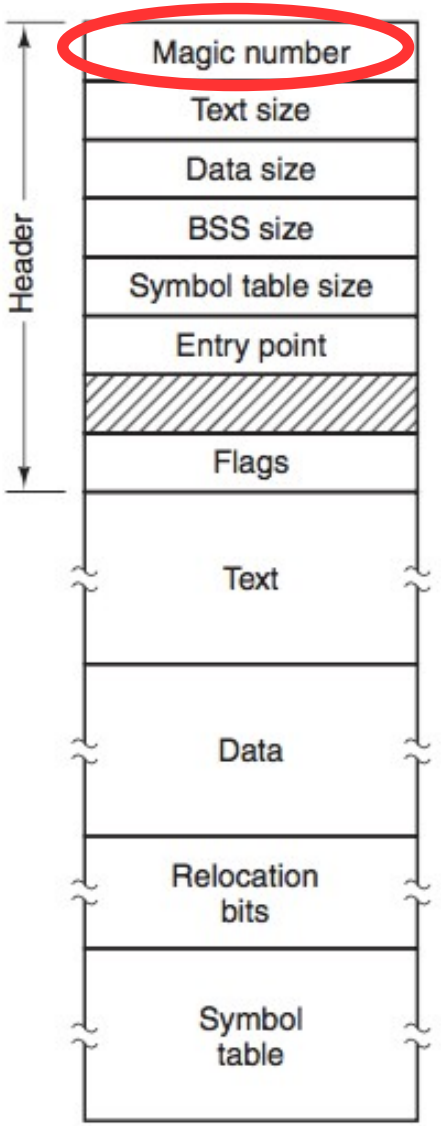
- Regular files: contain user information
  - Ascii or binary
- Directories: system files for maintaining the structure of the file system
- Character special files: related to input/output and used to model serial I/O devices (i.e., terminals, printers and networks.
- Block special files are used to model disks

Executable Files

- Technically a file is a sequence of bytes
- Formatted sequence of bytes with five sections
  - *Header (see next slides for more)*,
  - text,
  - data,
  - relocation bits,
  - symbol table

Binary File Headers

- Executable and Linkable Format (ELF, formerly called Extensible Linking Format) is a common standard file format for executables, object code, shared libraries, and core dumps.
- Header: "**Magic Number**"
  - Identifies the file format as *executable* or gives *datatype* (jpg, gif, etc.)
  - Number prevents other files from executing if not in proper format.
  - Visible by hex editors
  - A look-up table is required (hence, magic in meaning.)



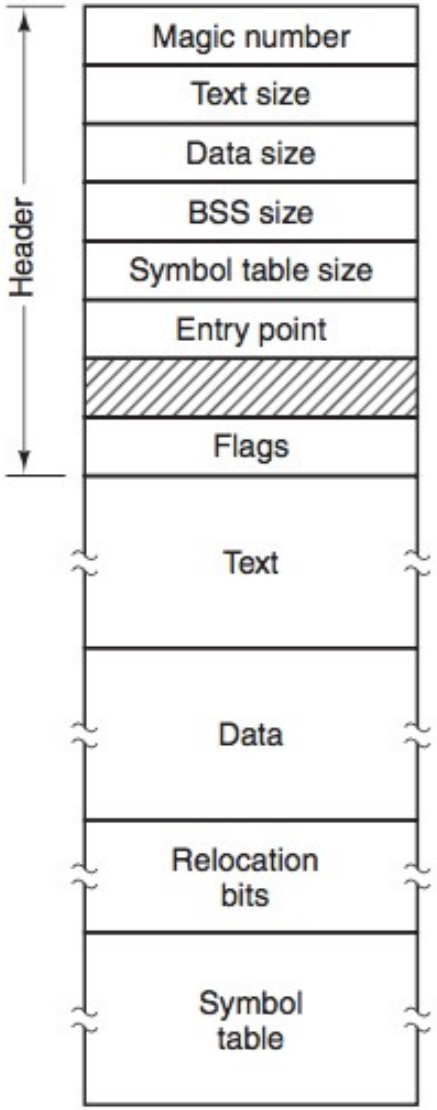
FYI: Magic Numbers

- 0x4A464946: a commonly used magic number for JPEG (Joint Photographic Experts Group) image files
  - The ASCII equivalent of JFIF (JPEG File Interchange Format)
- 0x474946383961: GIF89a formatted files
- 0x4D546864: MIDI (Musical Instrument Digital Interface) files
- 0x425a6831415925: bzip2 compressed files

ALLEGHENY COLLEGE

Anatomy of the Binary File

- Sizes /requirements of memory to use the file
- The address where execution begins
- Flags to control execution
- The text and data of the program itself.
- The relocation table assists in memory loading
- The Symbols table is used for debugging



Consider This...

- Locate the directory: *findMrRabbit/* and use shell commands to traverse and search the directories to find Mr. Rabbit.
  - `ls` to get a file listing
  - `cd directoryName` to go to a *child* directory
  - `cd ../` to go to a *parent* directory
  - `cat filename` to view a file to find Mr. rabbit.