

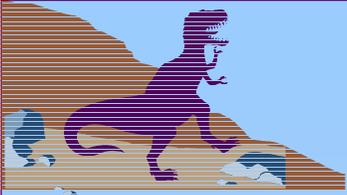
# Chapter 11: File-System Interface

- File Concept
- Access Methods
- Directory Structure
- File System Mounting
- File Sharing
- Protection



# File Concept

- Contiguous logical address space
- Types:
  - ◆ Data
    - ✓ numeric
    - ✓ character
    - ✓ binary
  - ◆ Program



# File Structure

- None - sequence of words, bytes
- Simple record structure
  - ◆ Lines
  - ◆ Fixed length
  - ◆ Variable length
- Complex Structures
  - ◆ Formatted document
  - ◆ Relocatable load file
- Can simulate last two with first method by inserting appropriate control characters.
- Who decides:
  - ◆ Operating system
  - ◆ Program

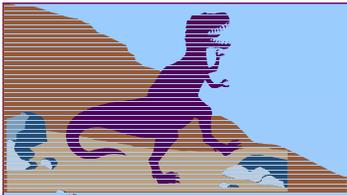




# File Attributes

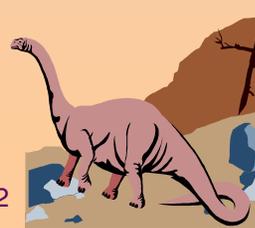
- **Name** – only information kept in human-readable form.
- **Type** – needed for systems that support different types.
- **Location** – pointer to file location on device.
- **Size** – current file size.
- **Protection** – controls who can do reading, writing, executing.
- **Time, date, and user identification** – data for protection, security, and usage monitoring.
- Information about files are kept in the directory structure, which is maintained on the disk.





# File Operations

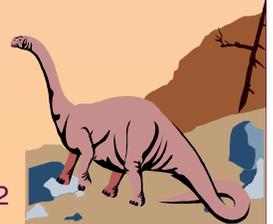
- Create
- Write
- Read
- Reposition within file – file seek
- Delete
- Truncate
- $\text{Open}(F_i)$  – search the directory structure on disk for entry  $F_i$ , and move the content of entry to memory.
- $\text{Close}(F_i)$  – move the content of entry  $F_i$  in memory to directory structure on disk.





# File Types – Name, Extension

file type	usual extension	function
executable	exe, com, bin or none	read to run machine- language program
object	obj, o	compiled, machine language, not linked
source code	c, cc, java, pas, asm, a	source code in various languages
batch	bat, sh	commands to the command interpreter
text	txt, doc	textual data, documents
word processor	wp, tex, rrf, doc	various word-processor formats
library	lib, a, so, dll, mpeg, mov, rm	libraries of routines for programmers
print or view	arc, zip, tar	ASCII or binary file in a format for printing or viewing
archive	arc, zip, tar	related files grouped into one file, sometimes com- pressed, for archiving or storage
multimedia	mpeg, mov, rm	binary file containing audio or A/V information



# Access Methods

## ■ Sequential Access

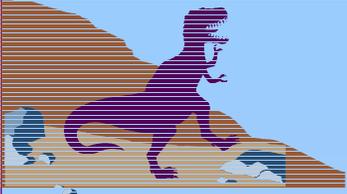
*read next*  
*write next*  
*reset*  
*no read after last write*  
*(rewrite)*

## ■ Direct Access

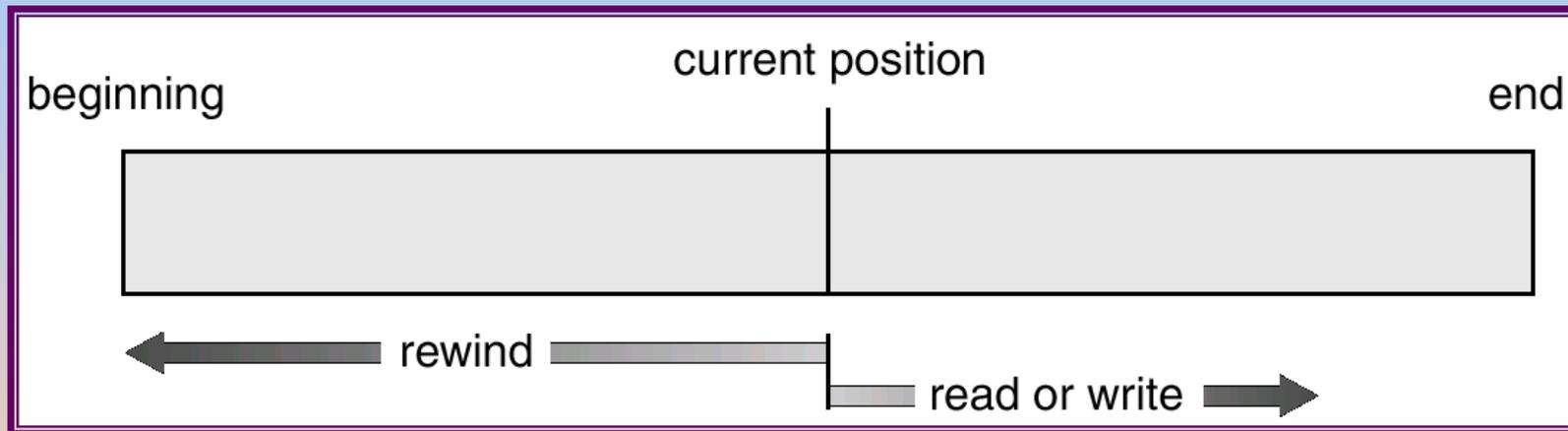
*read n*  
*write n*  
*position to n*  
*read next*  
*write next*  
*rewrite n*

$n$  = relative block number





# Sequential-access File

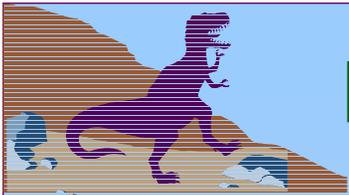




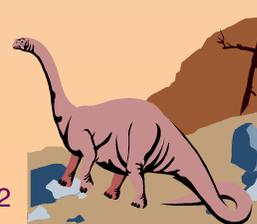
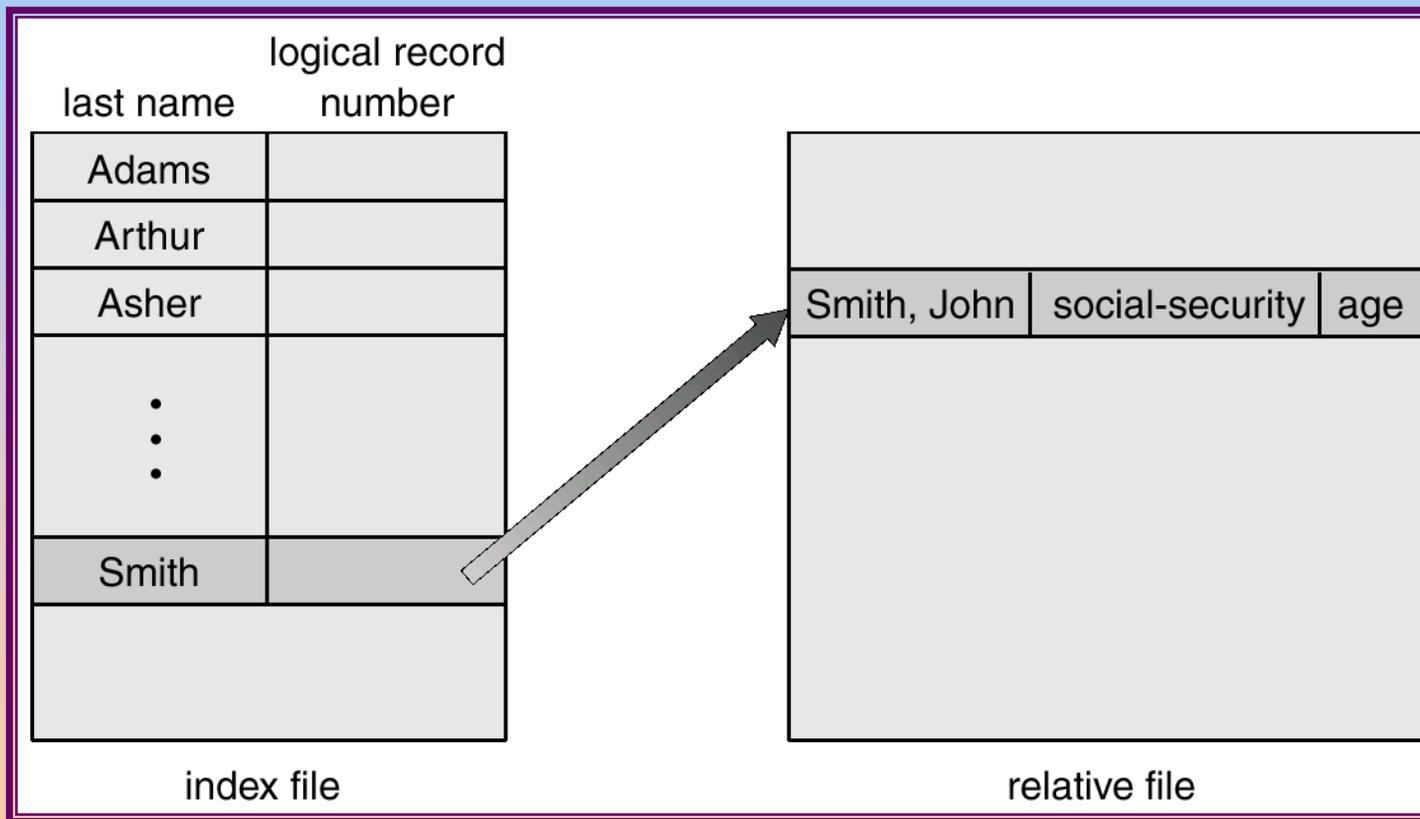
## Simulation of Sequential Access on a Direct-access File

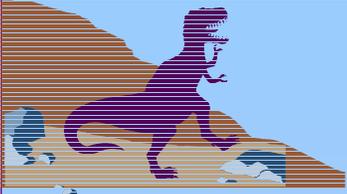
sequential access	implementation for direct access
<i>reset</i>	<i>cp = 0;</i>
<i>read next</i>	<i>read cp;</i> <i>cp = cp+1;</i>
<i>write next</i>	<i>write cp;</i> <i>cp = cp+1;</i>





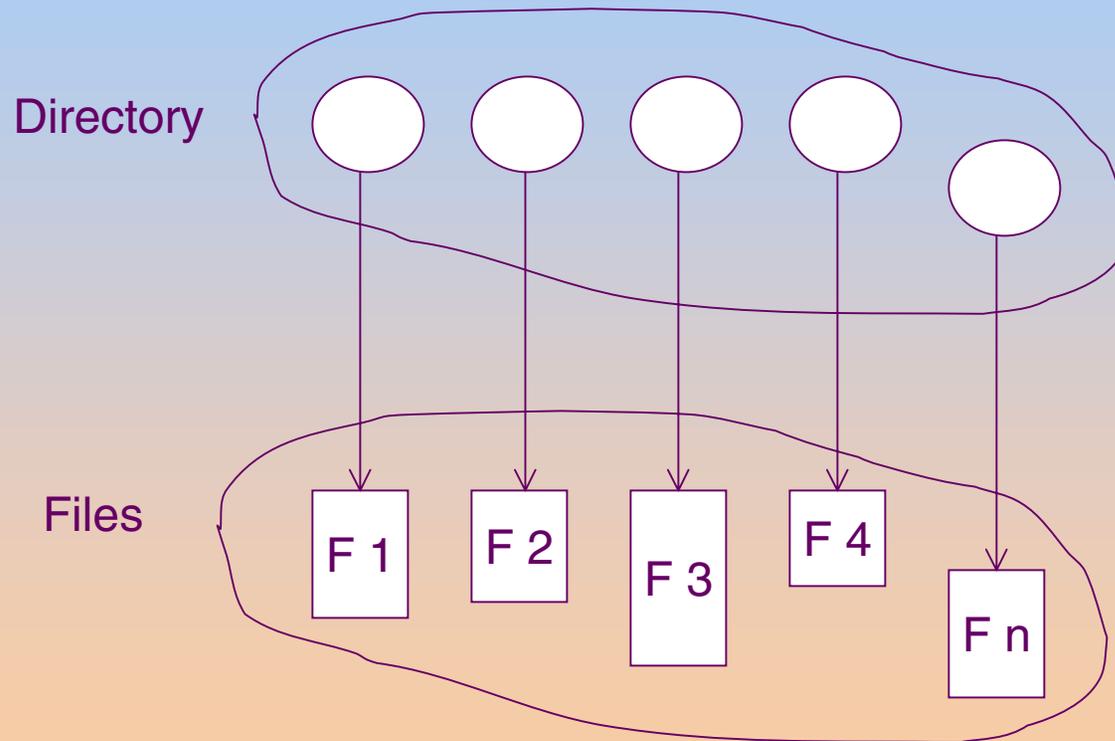
# Example of Index and Relative Files





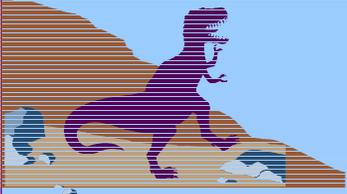
# Directory Structure

- A collection of nodes containing information about all files.

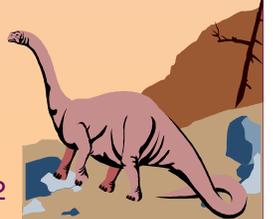
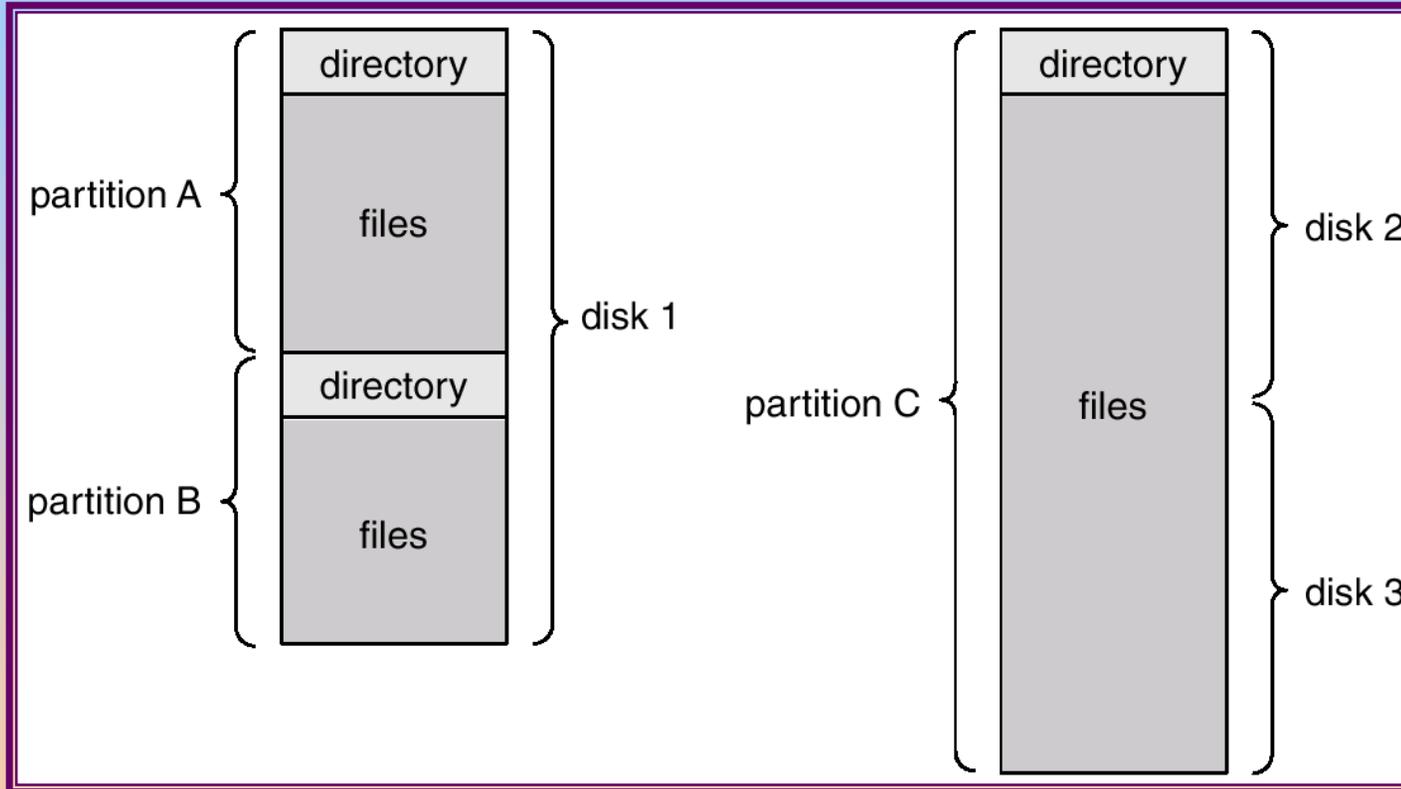


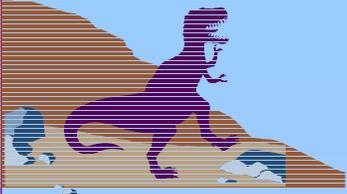
Both the directory structure and the files reside on disk.  
Backups of these two structures are kept on tapes.





# A Typical File-system Organization

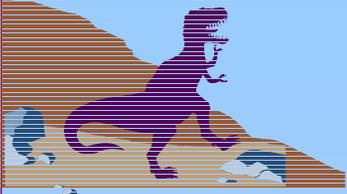




# Information in a Device Directory

- Name
- Type
- Address
- Current length
- Maximum length
- Date last accessed (for archival)
- Date last updated (for dump)
- Owner ID (who pays)
- Protection information (discuss later)





# Operations Performed on Directory

- Search for a file
- Create a file
- Delete a file
- List a directory
- Rename a file
- Traverse the file system

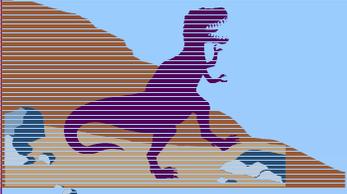




# Organize the Directory (Logically) to Obtain

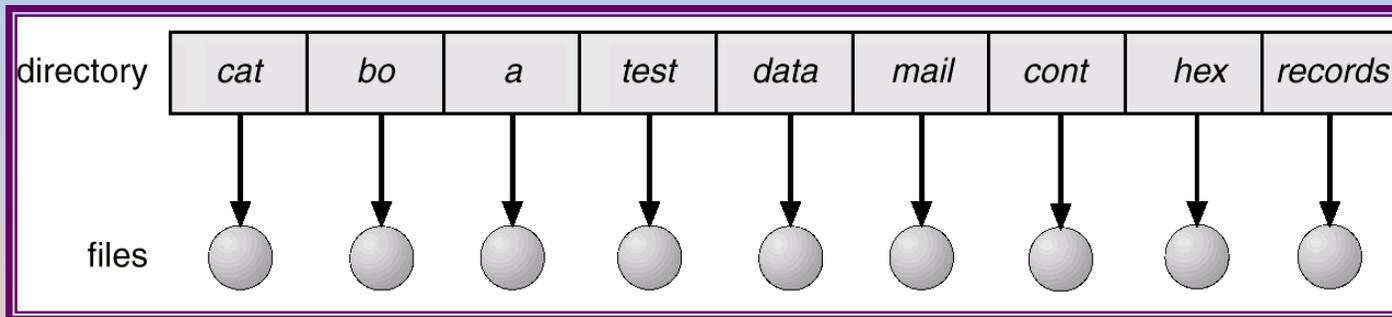
- **Efficiency** – locating a file quickly.
- **Naming** – convenient to users.
  - ◆ Two users can have same name for different files.
  - ◆ The same file can have several different names.
- **Grouping** – logical grouping of files by properties, (e.g., all Java programs, all games, ...)





# Single-Level Directory

- A single directory for all users.



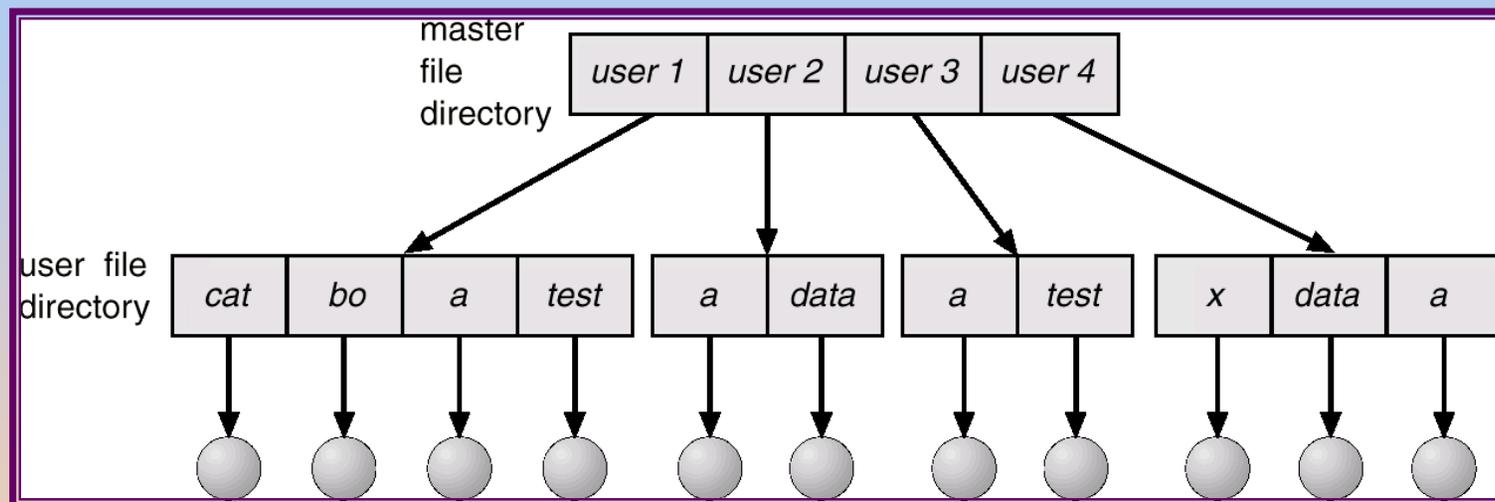
Naming problem

Grouping problem



# Two-Level Directory

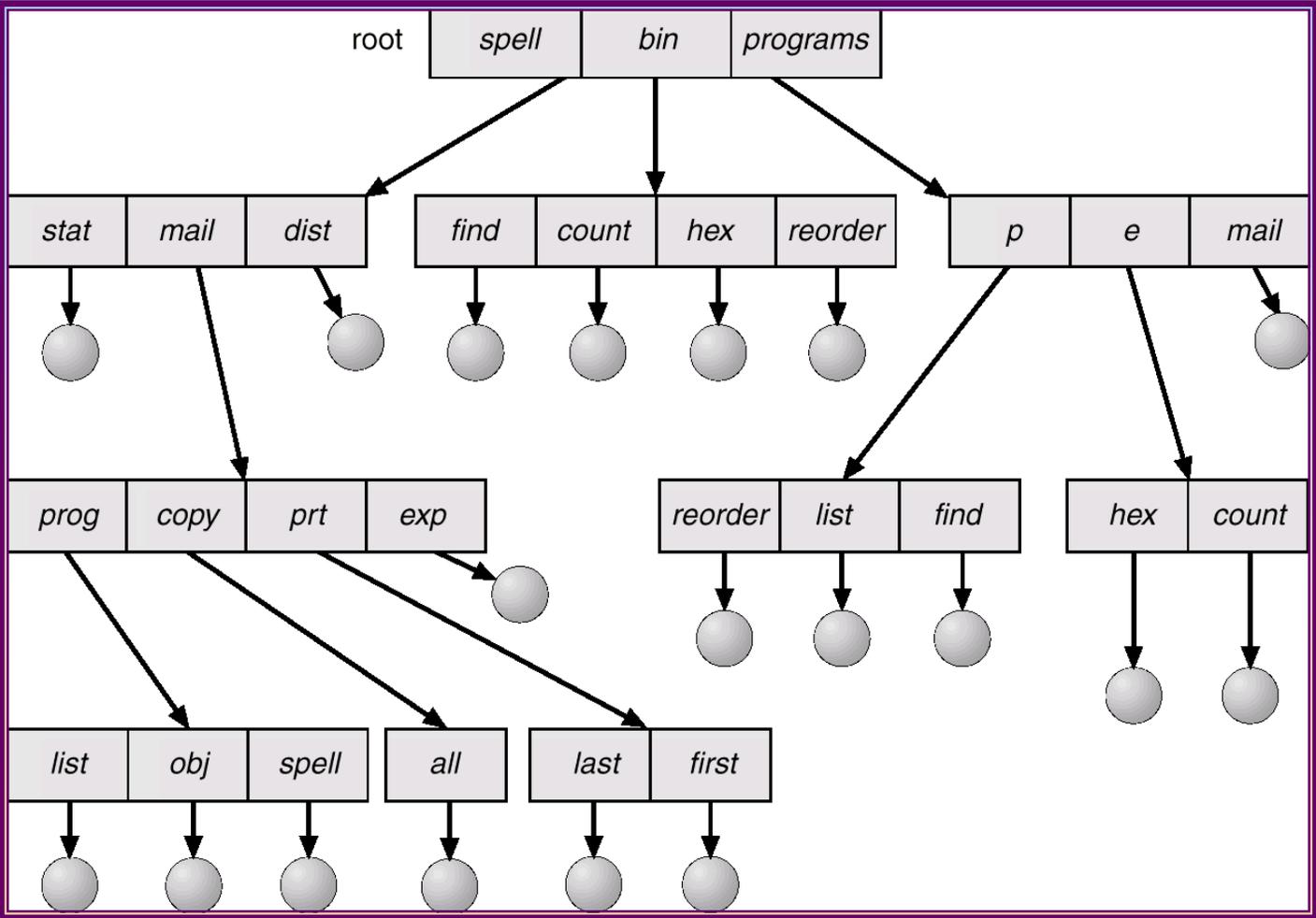
- Separate directory for each user.

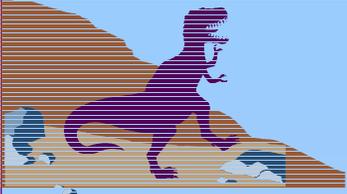


- Path name
- Can have the same file name for different user
- Efficient searching
- No grouping capability



# Tree-Structured Directories

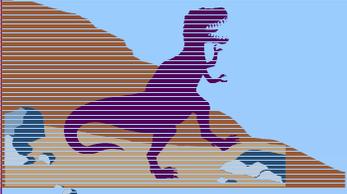




# Tree-Structured Directories (Cont.)

- Efficient searching
- Grouping Capability
- Current directory (working directory)
  - ◆ **cd** /spell/mail/prog
  - ◆ **type** list





# Tree-Structured Directories (Cont.)

- **Absolute** or **relative** path name
- Creating a new file is done in current directory.
- Delete a file

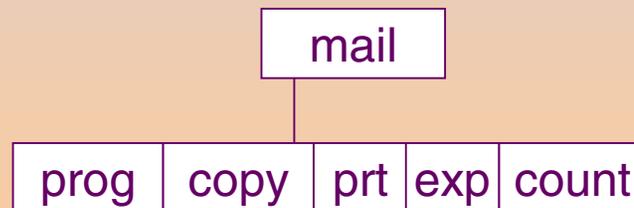
**rm** <file-name>

- Creating a new subdirectory is done in current directory.

**mkdir** <dir-name>

Example: if in current directory **/mail**

**mkdir** count



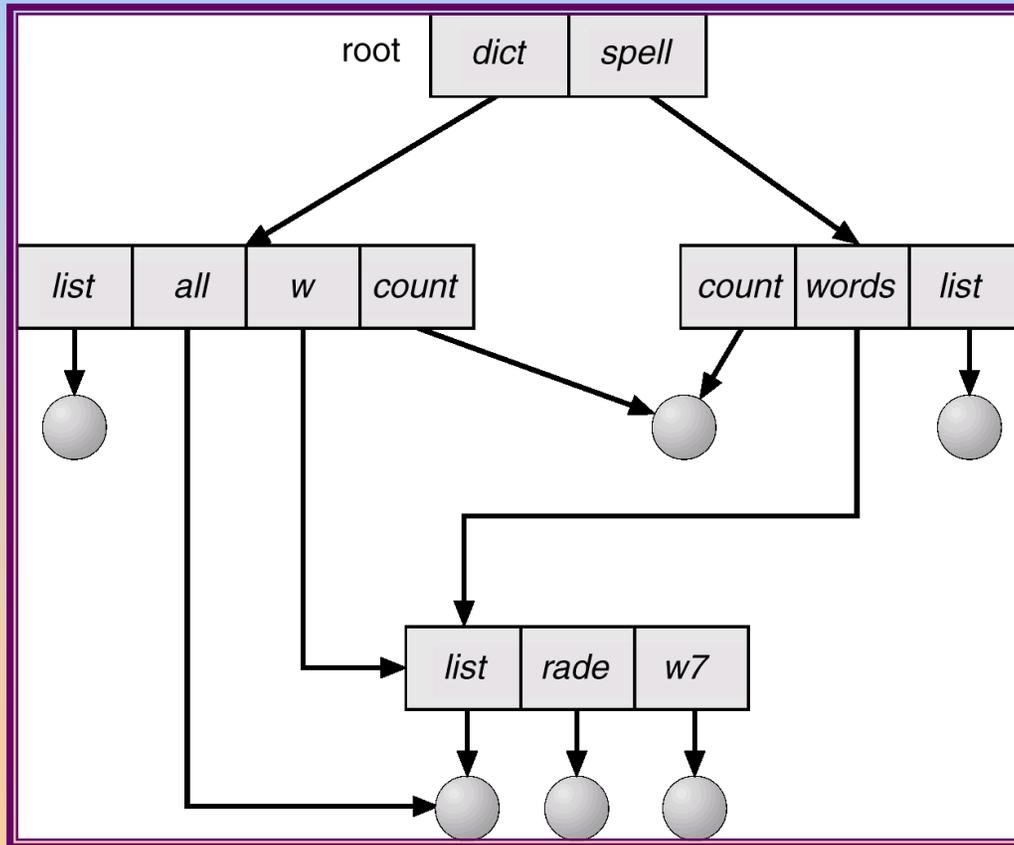
Deleting “mail” ⇒ deleting the entire subtree rooted by “mail”.





# Acyclic-Graph Directories

- Have shared subdirectories and files.





# Acyclic-Graph Directories (Cont.)

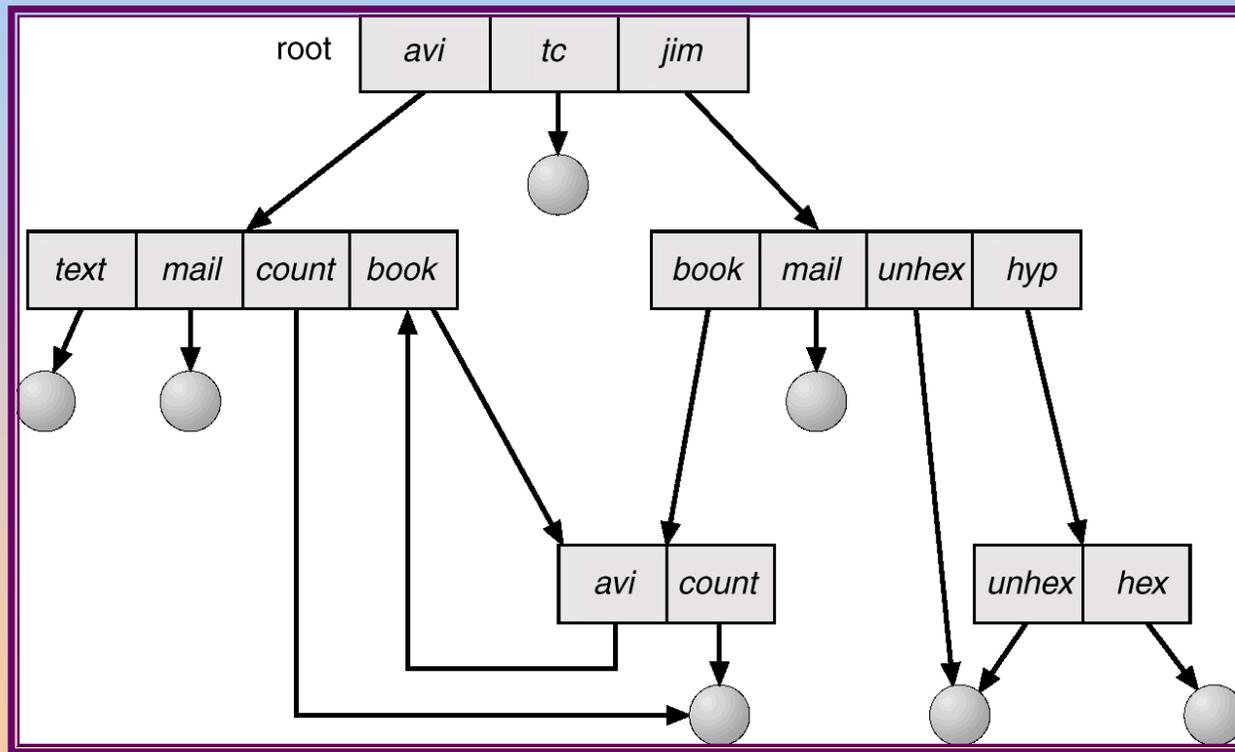
- Two different names (aliasing)
- If *dict* deletes *list*  $\Rightarrow$  dangling pointer.

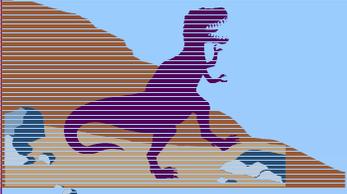
Solutions:

- ◆ Backpointers, so we can delete all pointers.  
Variable size records a problem.
- ◆ Backpointers using a daisy chain organization.
- ◆ Entry-hold-count solution.



# General Graph Directory

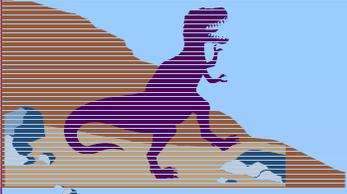




# General Graph Directory (Cont.)

- How do we guarantee no cycles?
  - ◆ Allow only links to file not subdirectories.
  - ◆ Garbage collection.
  - ◆ Every time a new link is added use a cycle detection algorithm to determine whether it is OK.



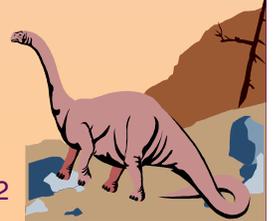
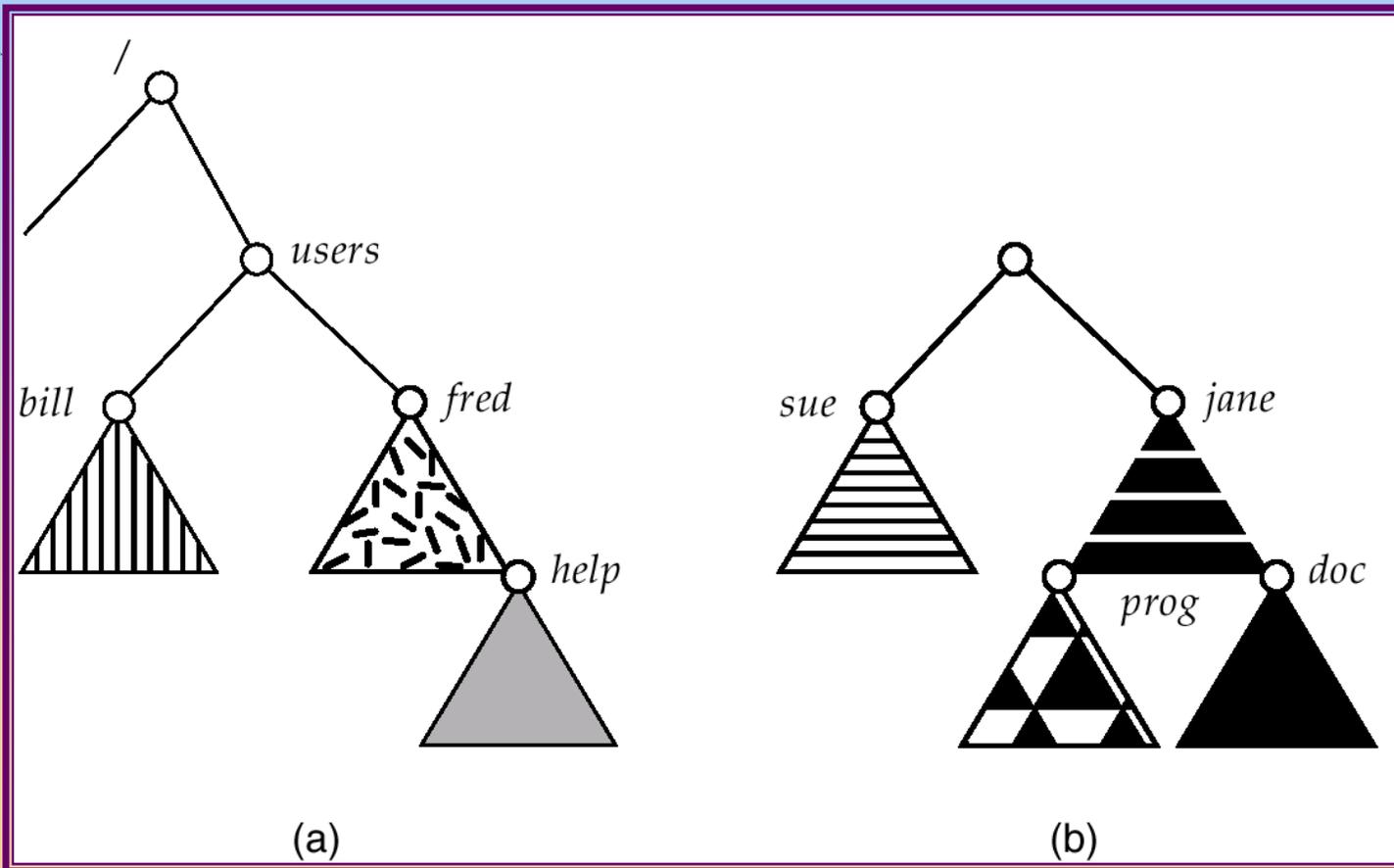


# File System Mounting

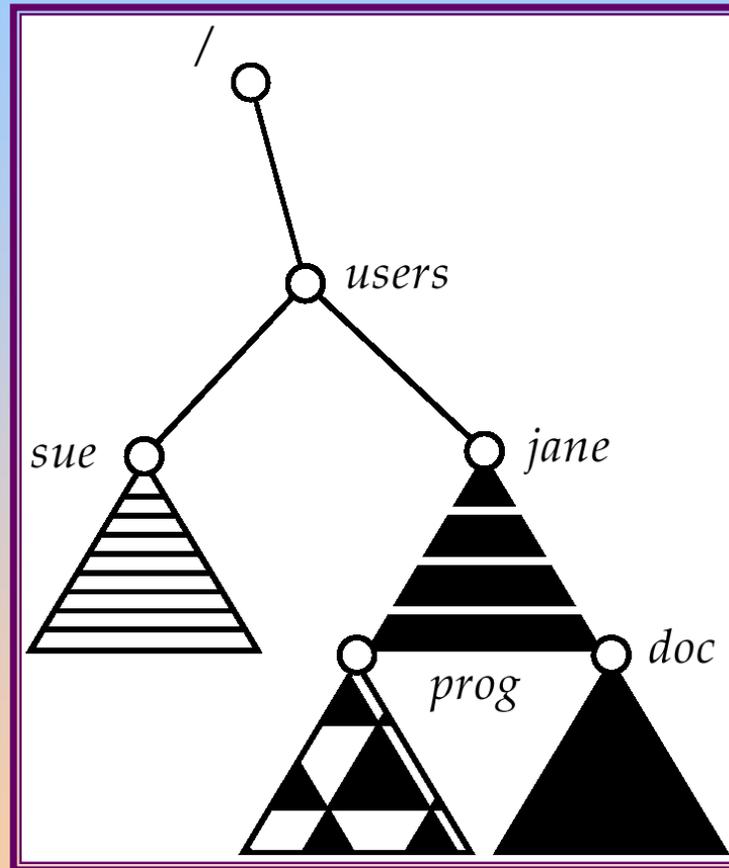
- A file system must be **mounted** before it can be accessed.
- A unmounted file system (I.e. Fig. 11-11(b)) is mounted at a **mount point**.



# (a) Existing. (b) Unmounted Partition



# Mount Point





# File Sharing

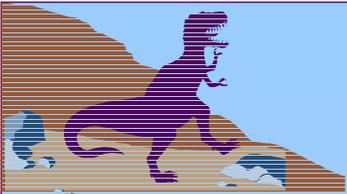
- Sharing of files on multi-user systems is desirable.
- Sharing may be done through a *protection* scheme.
- On distributed systems, files may be shared across a network.
- Network File System (NFS) is a common distributed file-sharing method.



# Protection

- File owner/creator should be able to control:
  - ◆ what can be done
  - ◆ by whom
  
- Types of access
  - ◆ Read
  - ◆ Write
  - ◆ Execute
  - ◆ Append
  - ◆ Delete
  - ◆ List



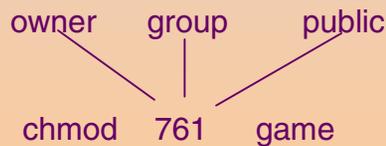


# Access Lists and Groups

- Mode of access: read, write, execute
- Three classes of users

			RWX
a) <b>owner access</b>	7	⇒	1 1 1
			RWX
b) <b>group access</b>	6	⇒	1 1 0
			RWX
c) <b>public access</b>	1	⇒	0 0 1

- Ask manager to create a group (unique name), say G, and add some users to the group.
- For a particular file (say *game*) or subdirectory, define an appropriate access.



Attach a group to a file

chgrp G game

