Precept 6: File Systems

COS 318: Fall 2018

Project 6 Schedule

- **Precept:** Monday 12/10, 7:30pm
  - (You are here)
- **Design Review:** N/A
- **Due:** Tuesday 01/15, 5:00pm (Dean’s Date)
  - No late submissions!

Design Document

- No design review!
- Submit pdf describing design decisions + implementation details instead
- Submit with project on Dean’s Date
- See project spec for more info

Project 6 Overview

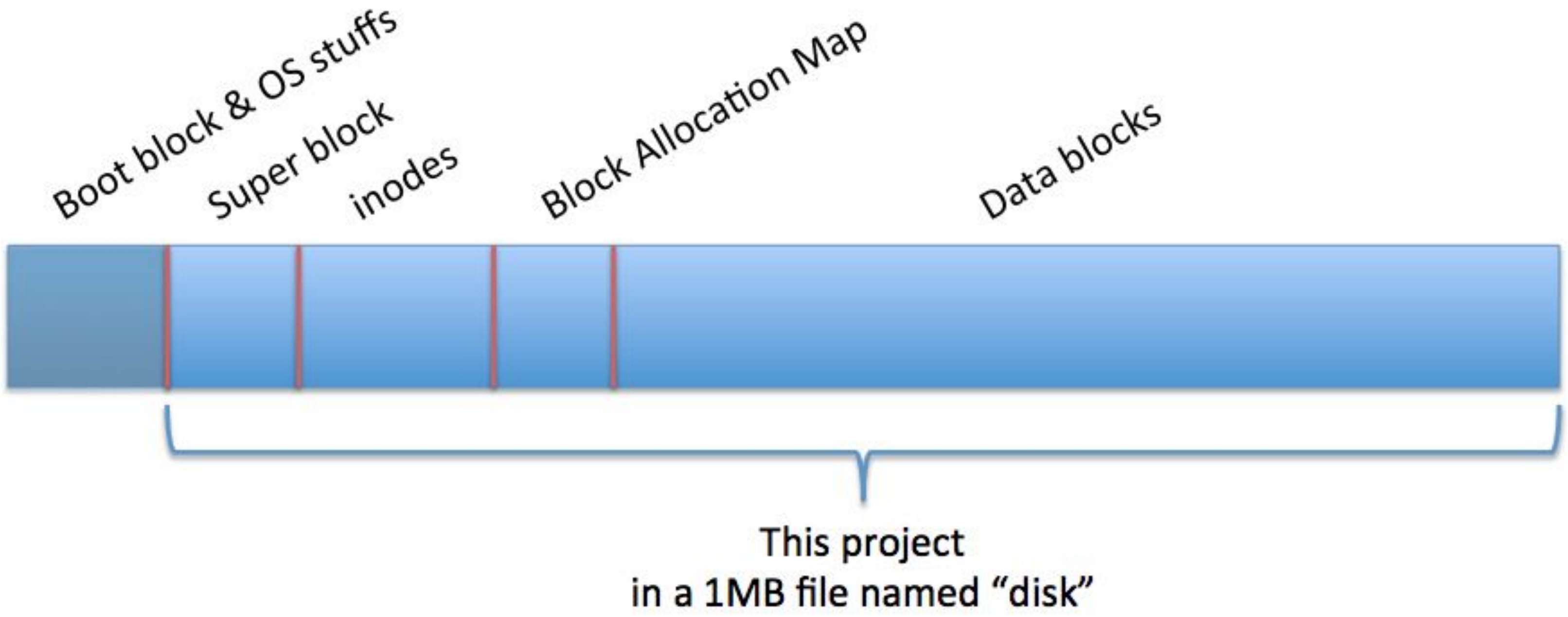
- **Goal:** Implement simple UNIX-like file system
- Manage disk space with dynamic file sizes
- Implement system calls and shell commands to interact with the file system
- Don't worry about concurrency, permissions, or performance

Project Description

API

- Format disk
- File
  - open, close, read, write, seek
  - link and unlink
  - stat
- Directory
  - make, remove, stat, etc.
- Shell commands
  - ls and chdir (cd)

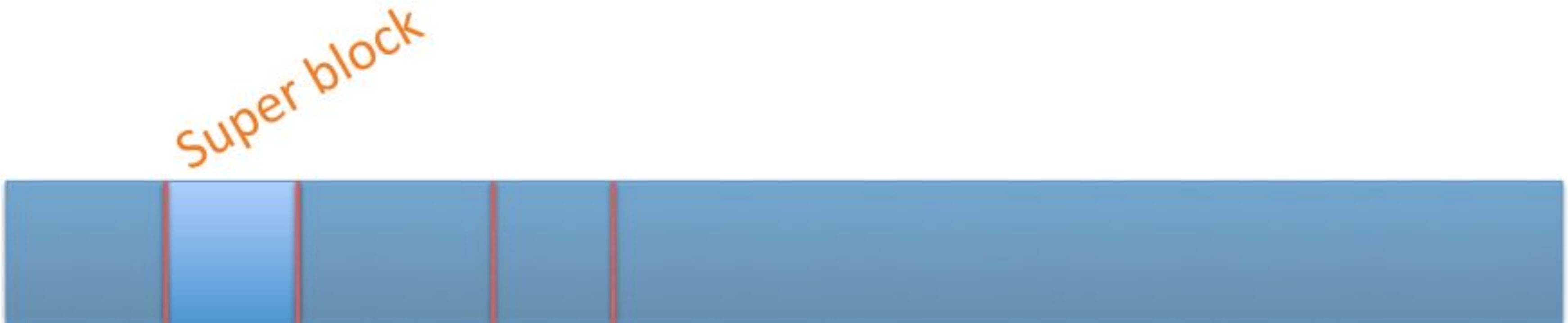
Disk Layout



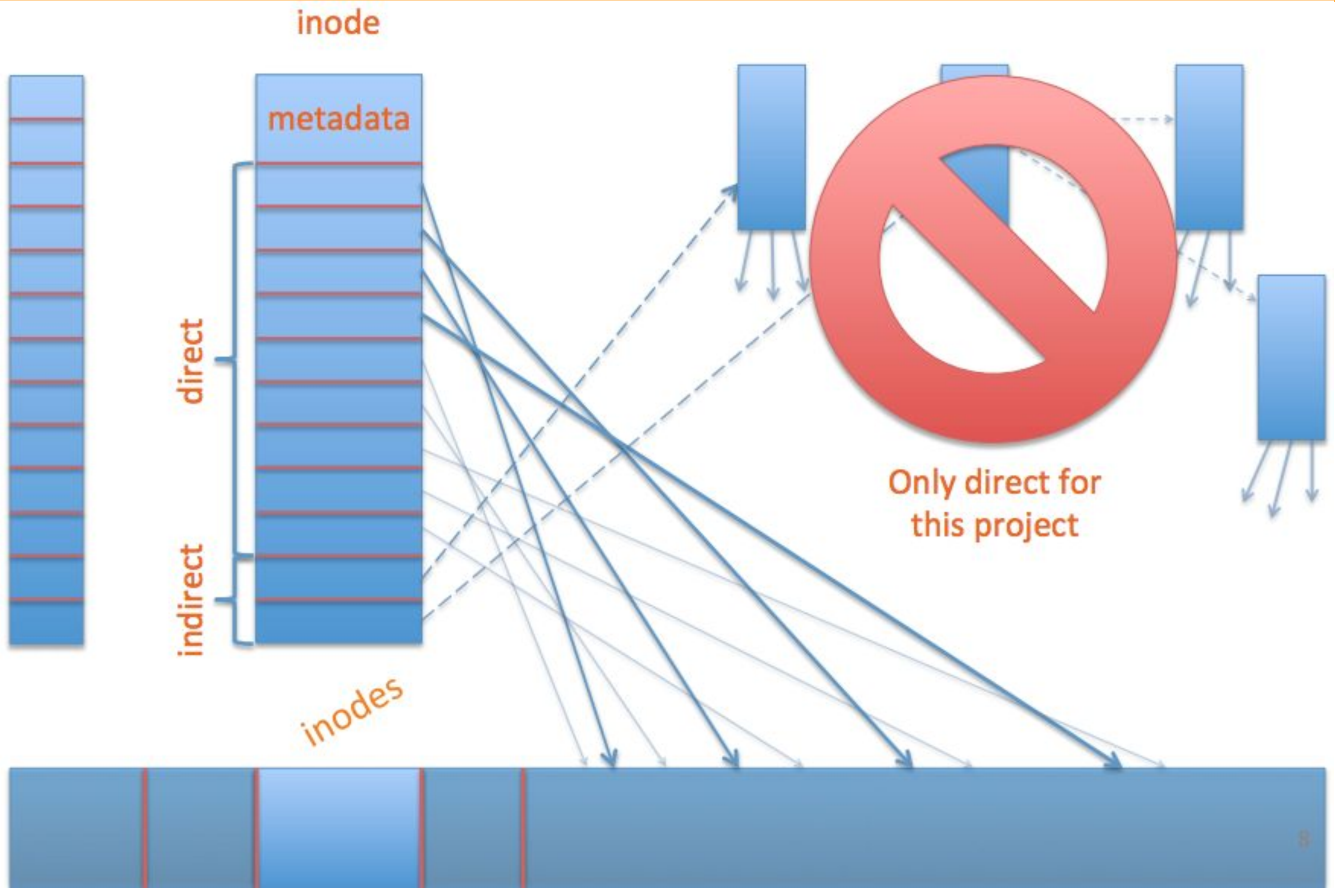
(Space between divisions not representative of actual size)

Superblock: Disk Metadata

- Examples:
  - Size
  - # inodes / DBs
  - Inode / DB start
  - Magic number



Inodes: File Metadata



Inodes: File Metadata

- Examples:
    - File or dir.
    - Size
    - Link count
    - etc.

`fs_init`

- "Constructor" for the FS
- Call `block_init()` to initialize the device
- Init resources used by the FS
- Format disk or mount if already formatted
    - How will you know if disk is formatted?

fs_mkfs

- Formats the disk
    - Write the super block
    - Mark inodes and data blocks as free
    - Create root directory
    - Initialize file descriptor table

File Creation and Deletion

- `fs_open()`: Create a new file if it does not exist
- `fs_link()`: Hard link to an existing file
- `fs_unlink()`:
  - Delete a file if link count == 0
  - Delete directory entry
  - Special behavior if file is still open (look at the project description)

File Access

- `fs_open()`: Open an existing file (allocate file descriptor)
- `fs_read()`: Read bytes from an open file
- `fs_write()`: Write bytes to an open file
- `fs_lseek()`: Change position in a file
- `fs_close()`: Close an existing file (free file descriptor)

`fs_lseek()` Semantics

- In this project, `fs_lseek()` takes only two arguments:
  - file descriptor and offset
- In Unix, `lseek()` takes three arguments:
  - file descriptor, offset, and whence (`SEEK_SET`, `SEEK_CUR`, `SEEK_END`)
- `fs_lseek()` will assume whence == `SEEK_SET`
- What if `fs_lseek()` tries to seek past end of file? (look at the project description)

Directories - Part 1

- Like a file, but contains a list of files and directories (name to inode number mapping)
- Can read it like a file:
  - Use your file I/O functions (`fs_*`) to do directory manipulation
- Always has at least two entries:
  - Current directory: “.”
  - Parent directory: “..”

Directories - Part 2

- `fs_mkdir()`: Make a directory
  - Create a directory entry in parent directory
  - Create the two directories "." and ".."
- `fs_rmdir()`: Remove directory if empty
- `fs_cd()`: Change the current directory
  - Only need to implement for relative path names

fs_mkdir() Example

```
int fs_mkdir(char *fileName)
{
    if (fileName exists) return ERROR;
    // allocate inode
    // allocate data blocks
    // set directory entries for “.” and “..”
    // set inode entries appropriately
    // update parent
    return SUCCESS;
}
```

Miscellaneous

- You don’t need to support absolute path names
- You don’t need to support recursive directory removal
- Implement a file system check (`fsck`) tool for debugging that verifies integrity of:
  a. Superblock magic number
  b. Block allocations
  c. Inode allocations
  d. Block allocation map
  e. Directory content
  f. Etc.

Implementation

- In Linux:
  - Uses a file to simulate a disk
  - Code is provided
  - Execute `./lnxsh`
- Shell supports:
  - System calls for file system
  - Commands: "`ls`", "`cat foo`", "`create foo 200`"
- You will have to write a lot of code (1,000+)

Testing

- A python script for testing is provided
- Multiple tests that each:
    - Execute the shell
    - Open an existing file system (or format a new one)
    - Write commands to the shell (i.e. "`cat foo`")
    - Read output from the shell (i.e. ABCDEF)
    - Exit
- You should also write your own test cases
- Submit them with your code

Questions?