Project 6
File System

COS 318

Fall 2016

Project 6: File System

- Goal: Implement a simple UNIX-like file system with a hierarchical directory structure.
- Read the project spec for the details.
- Get a fresh copy of the start code from the lab machines (/u/318/code/project6/).
- Start as early as you can. This is a long project and you will have to write a lot of code.

Project 6: Schedule

- Design Review:
  - No design review!
  - You will submit a pdf file with your project that describes the details about the design of your file system.
  - Look at the “Design Document” section of the project description for the content of the document that you need to write.
- Due date: Tuesday 1/10/2016 (Dean’s date), 5:00pm.

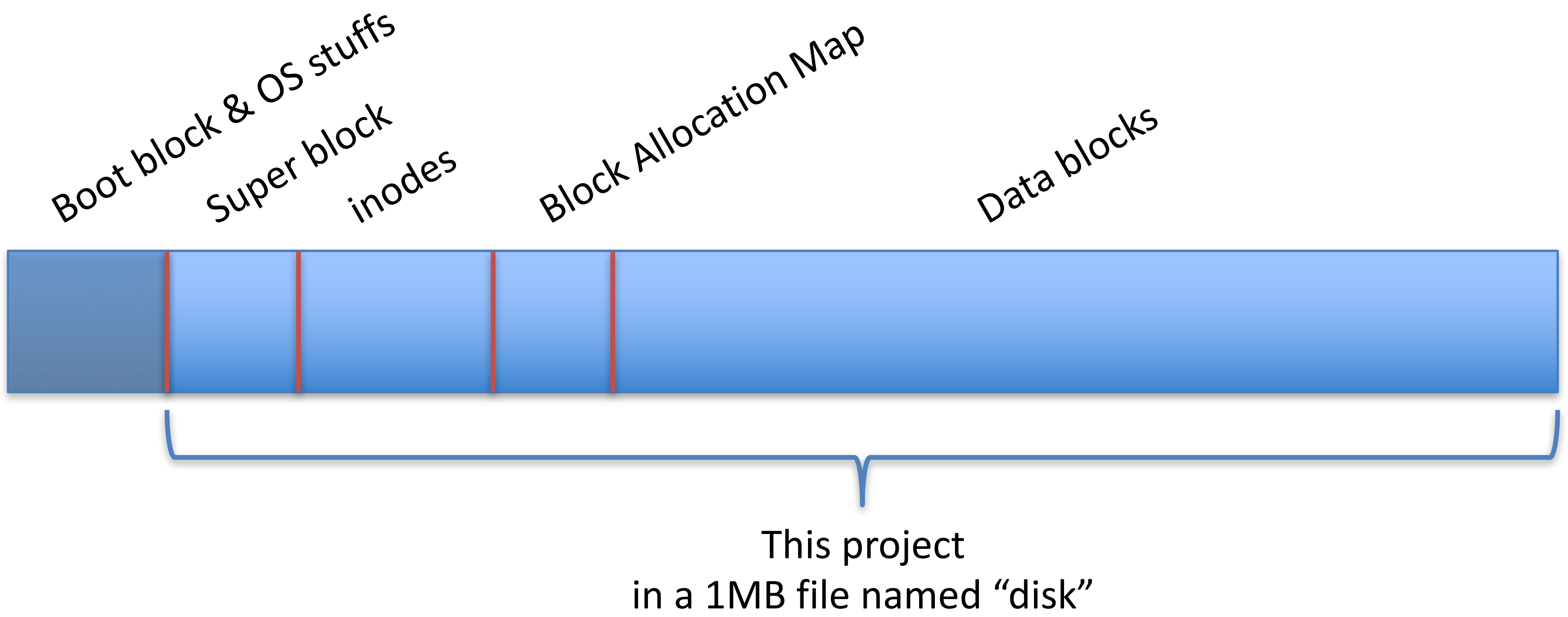
Project 6: Overview

- Implement a simple UNIX-like file system with a hierarchical directory structure
- Manage disk space, as files and directories grow and shrink.
- Implement commands and system calls to browse the directory structure, create new files and directories, delete them, etc.
- Don’t need to worry about concurrency, permissions, or high performance.

API

- Disk format
- File
  - open, close, read, write, seek
  - link and unlink (delete a file)
  - stat
- Directory
  - make, remove, stat, etc.
- Shell commands
  - ls and chdir (cd)

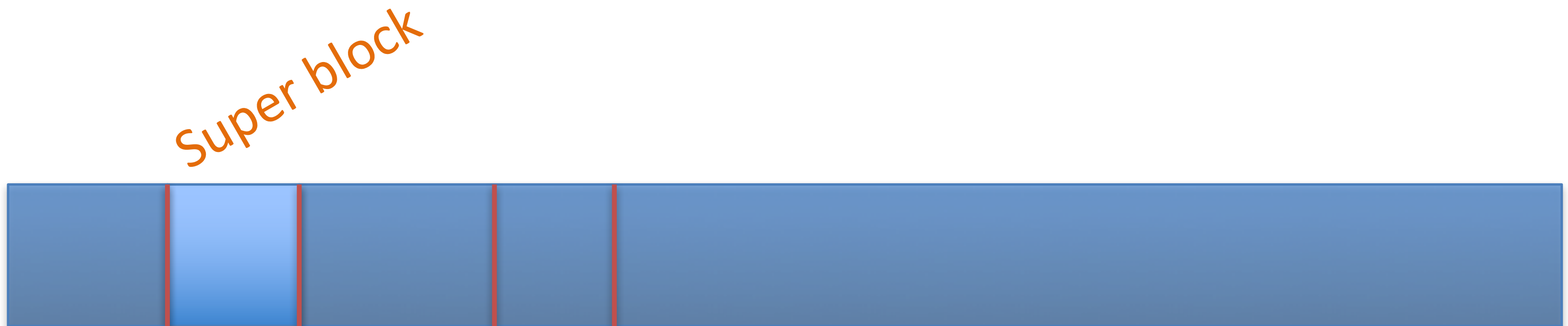
Disk Layout



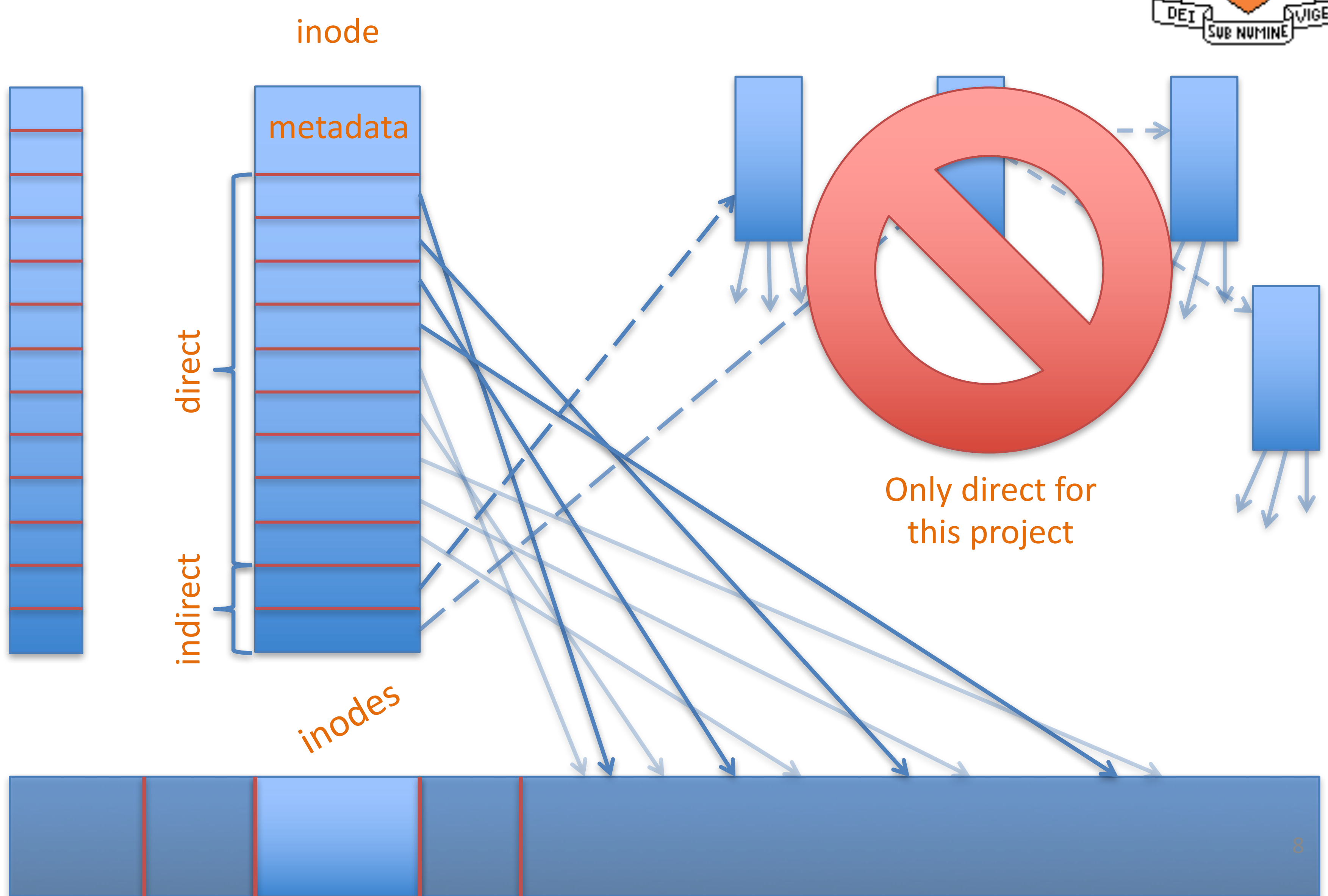
Space between divisions is not representative of actual size.

Superblock – Disk Metadata

- Examples:
  - Size
  - # of inodes
  - # of data blocks
  - Where inodes start
  - Where data blocks start
  - Magic number



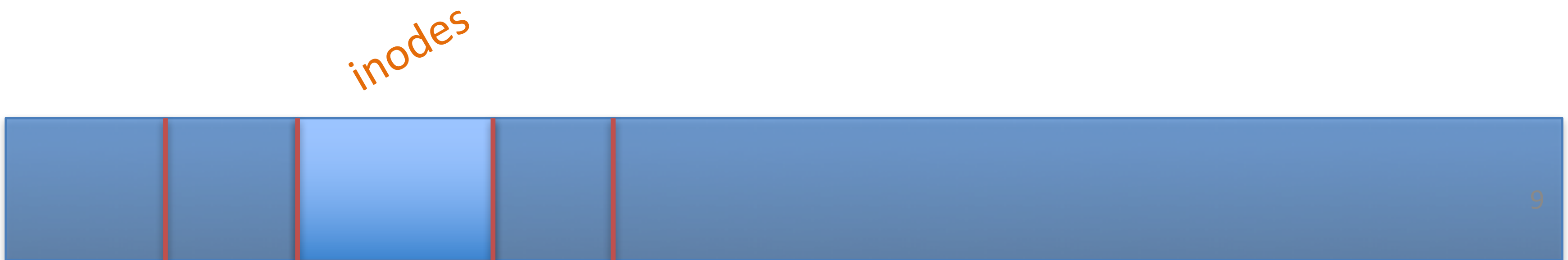
Inodes



Only direct for this project

Inode – Metadata

- Examples:
  - File or directory?
  - Link count
  - Size
  - Etc..



fs_init

- A “constructor” for the FS code.
- Call block_init() to initialize the block “device.”
- Initialize data structures and resources used by the file system.
- Format the disk or mount it if it is already formatted (create a mechanism to detect if the disk is formatted).

fs_mkfs

- “Makes” a file system:
  - Write the super block;
  - Mark inodes and data blocks as free;
  - Create root directory;
  - Initialize file descriptor table.

File Creation and Deletion

- fs_open(), fs_link(), fs_unlink().
- open: create a new file if it does not exist.
- link: hard link to a file
  - Create a link to an existing file
- 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

- open: open an existing file (allocate file descriptor).
- read: read bytes from an open file.
- write: write bytes to an open file.
- lseek: change position in a file.
- close: free file descriptor.

fs_lseek() Semantics

- This project fs_lseek() takes only two arguments:
  - file descriptor and offset.
- Unix lseek() takes three arguments:
  - File descriptor, offset, whence.
- Whence: SEEK_SET, SEEK_CUR, SEEK_END.
- ls_lseek() assumes SEEK_SET.
- What if lseek() wants to seek past the end of the file? (look at the project description for the expected behavior)

Directories – Part 1

- Like a file: 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

- mkdir: make a directory.
  - create an entry in parent directory;
  - create two directories: “.” and “..”.
- rmdir: remove directory if empty.
- cd: change the current directory
  - for relative path names only.

Example – fs_mkdir

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

Misc

- 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:
  - Superblock magic number;
  - Block allocations;
  - Inode allocations;
  - Block allocation map;
  - Directory content;
  - 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:
  - Over 1,000 lines of code.

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 (cat foo);
  - read output from the shell (ABCDEF);
  - exit.
- You should also write your own test cases:
  - submit them with your code.