

Project #2: User Program (2)

Operating System (CSE4070) Project

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Prof. Youngjae Kim

TA: Seonghoon Ahn, Hyunsun Chung

Sangyun Lee, Hyungsun Yoo

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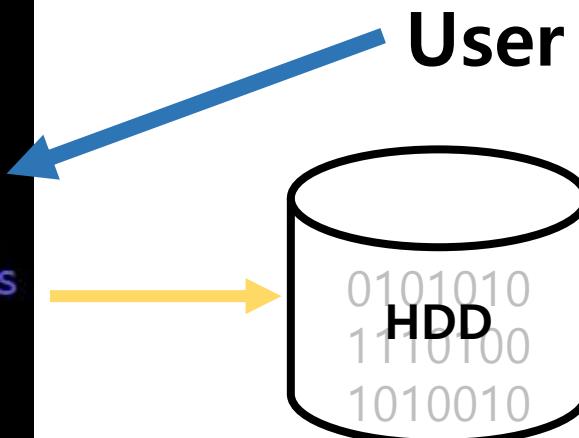
What to do?

- **Implement system calls about file system**
 - System calls
 - create, remove, open, close, filesize, read, write, seek, tell
 - See Pintos manual p.29~32 for system call implementation.

What is File system?

```
:~$ ls -l
```

| ext4 | | | | | | | |
|------------|----|--|------|-----|----|-------|-----------|
| total | 28 | | | | | | |
| -rw-r--r-- | 1 | | 186 | Nov | 1 | 00:31 | a.c |
| -rw-r--r-- | 1 | | 3319 | Nov | 1 | 00:32 | a.txt |
| drwxr-xr-x | 2 | | 4096 | Oct | 31 | 02:54 | Desktop |
| drwxr-xr-x | 2 | | 4096 | Oct | 31 | 02:54 | Downloads |
| drwxr-xr-x | 2 | | 4096 | Oct | 31 | 02:58 | example |
| drwxr-xr-x | 2 | | 4096 | Oct | 31 | 19:50 | test |
| drwxr-xr-x | 7 | | 4096 | Nov | 1 | 00:30 | tmp |



```
#include <stdio.h>

int main(){
    .....
    FILE* fp = fopen("test/input.txt", "r");
    .....
}
```

Access

Base File System

Base File System

- **To implement system call about file system,
we need to understand base file system of Pintos**
 - We need to interface to the file system code. So, we need to know **API usage**.
 - Pintos provides simple but complete file system.
(Look `filesys.h` and `file.h` at `filesys/`)
 - Don't need to understand whole structure of file system.
 - No need to modify the file system code for this project.

Base File System

- **Limitation of Base File System (See also p.23-24):**
 - No internal synchronization
 - File size is fixed at creation time
 - File data is allocated as a contiguous range of sectors on disks
 - No subdirectories
 - File name length limitation (up to 14 characters)

Base File System

- **Usage about file system on project 2**
 - There is no sub-directories.
 - We assume that we work on root directory (/) of file system.

- **File access at Kernel**

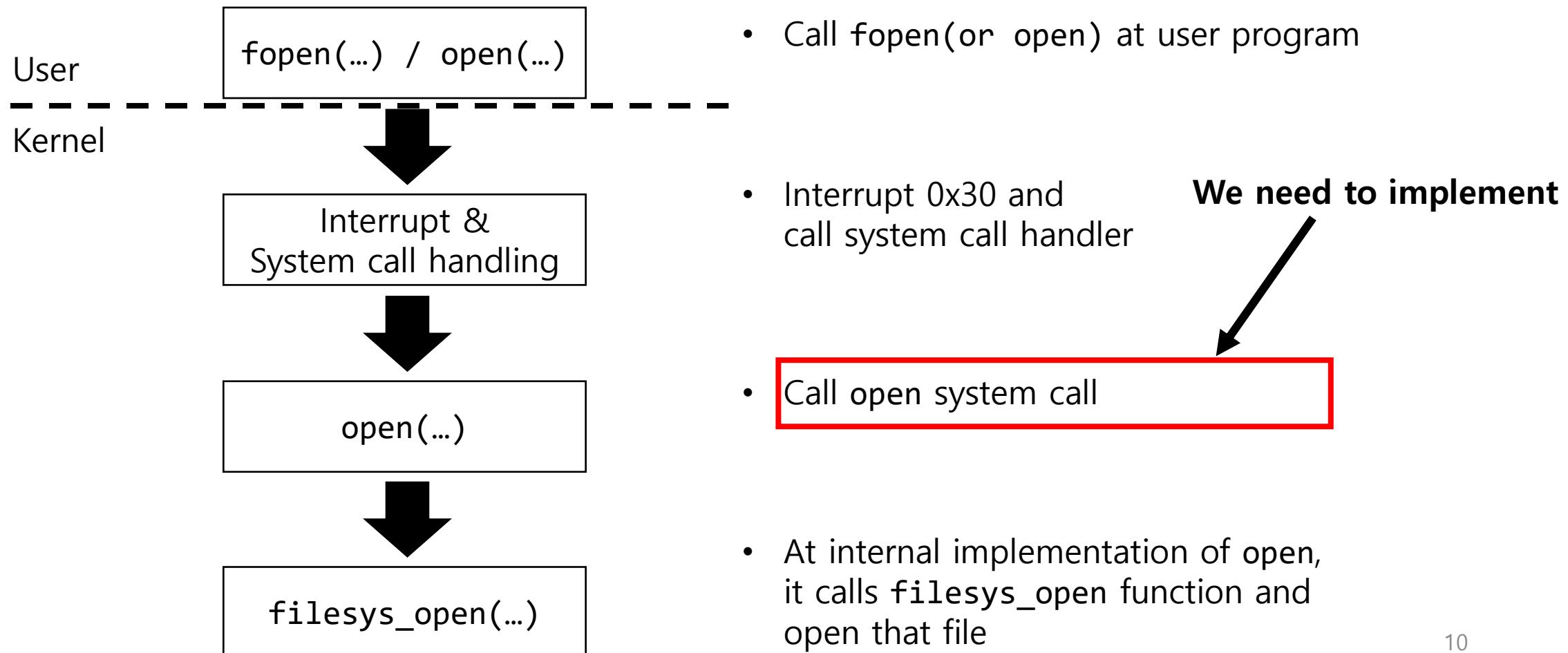
- Can access through struct file (See `filesys/file.c`)
- (At this project, it doesn't need to access on inode level)

```
/* An open file. */
struct file
{
    struct inode *inode;          /* File's inode. */
    off_t pos;                  /* Current position. */
    bool deny_write;             /* Has file_deny_write() been called? */
};
```

File System Call Implementation

File System Call Implementation

- **Basic file system usage interfaces:**



File System Call Implementation

- Example in Pintos

```
/* Open a file. */

#include <syscall.h>
#include "tests/lib.h"
#include "tests/main.h"

void
test_main (void)
{
    int handle = open ("sample.txt");
    if (handle < 2)
        fail ("open() returned %d", handle);
}
```

```
int
open(const char *file)
{
    .....
    struct file * f = filesystem_open(...);
    .....
}
```

```
struct file *
filesystem_open (const char *name)
{
    struct dir *dir = dir_open_root ();
    struct inode *inode = NULL;
    if (dir != NULL)
        dir_lookup (dir, name, &inode);
    dir_close (dir);

    return file_open (inode);
}
```

System call acts like interfaces for calling file_xxx

File System Call Implementation

- **File Descriptor (Similar to FILE * of standard C)**
 - Return value of open, create
 - At Pintos, each thread get and manage independent file descriptor.
 - File descriptor of STDIN, STDOUT, STDERR
 - STDIN = 0
 - STDOUT = 1
 - (At Linux or other OSes, STDERR = 2)

File System Call Implementation

- **read and write with stdin/stdout**
 - Read from stdin – read(0)
 - Use `uint8_t input_getc(void)` (`devices/input.c`)
 - Write to stdout – write(1)
 - Use `void putbuf(...)` (`lib/kernel/console.c`)

Useful APIs

- **filesys/filesys.h**

```
bool filesys_create (const char *name, off_t initial_size);
struct file *filesys_open (const char *name);
bool filesys_remove (const char *name);
```

- **filesys/file.h**

```
/* Opening and closing files. */
struct file *file_open (struct inode *);
void file_close (struct file *);

/* Reading and writing. */
off_t file_read (struct file *, void *, off_t);
off_t file_write (struct file *, const void *, off_t);

/* Preventing writes. */
void file_deny_write (struct file *);
void file_allow_write (struct file *);

/* File position. */
void file_seek (struct file *, off_t);
off_t file_tell (struct file *);
off_t file_length (struct file *);
```

Kernel Functions

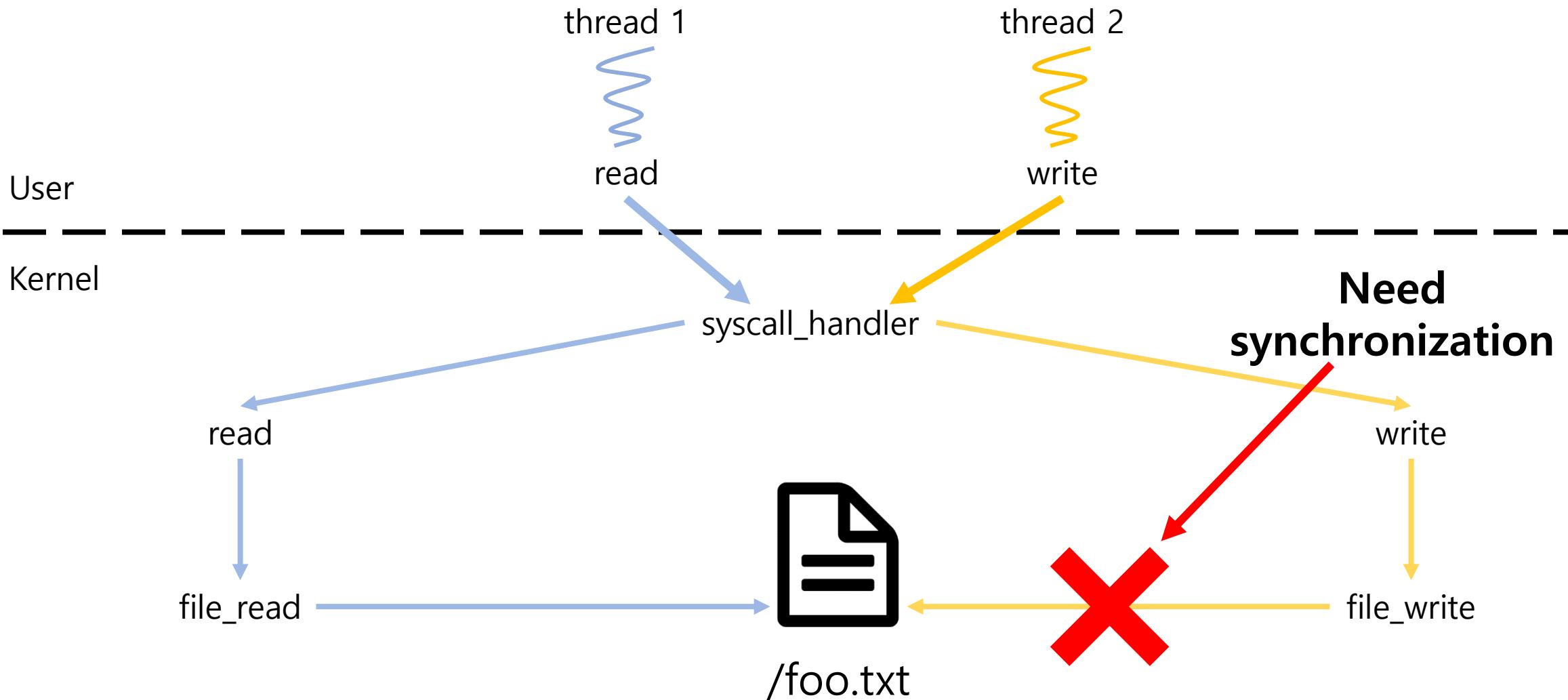
Denying Writes to Executable files

- **Process is executed after load to memory.**
 - So, removing executable file may not be a problem after executed.
- **But Pintos doesn't want to delete executable file of running program.**
- **These file system function may be useful for this problem:**
 - `void file_deny_write(struct file *)` (filesys/file.c)
 - `void file_allow_write(struct file *)` (filesys/file.c)

Protect Critical Section

- **Critical Section**
 - N Processes all competing to use some shared data
 - Each Process has a code segment, called **critical section**, in which the **shared data is accessed**
 - Problem: Ensure that when one process is executing in its critical section, **no other process can execute** in its critical section
- **Using test case of Pintos, check code segment that should be considered as critical section**
 - Protect this code segment using synchronization APIs.
 - ex) syn-read, syn-write

Critical Section – Example in Pintos



Synchronization APIs (See also p.67-68)

- **Lock**

```
/* Lock. */
struct lock
{
    struct thread *holder;      /* Thread holding lock (for debugging). */
    struct semaphore semaphore; /* Binary semaphore controlling access. */
};

void lock_init (struct lock *);
void lock_acquire (struct lock *);
bool lock_try_acquire (struct lock *);
void lock_release (struct lock *);
bool lock_held_by_current_thread (const struct lock *);
```

Synchronization APIs (See also p.67-68)

- **Semaphore**

```
/* A counting semaphore. */
struct semaphore
{
    unsigned value;                      /* Current value. */
    struct list waiters;                 /* List of waiting threads. */
};

void sema_init (struct semaphore *, unsigned value);
void sema_down (struct semaphore *);
bool sema_try_down (struct semaphore *);
void sema_up (struct semaphore *);
void sema_self_test (void);
```

Evaluation and Submission

Evaluation

1. Rest of 76 tests remained from project 1 will be graded. (Total 55 of 76 tests)
 - Refer to the test case list in the next slide
2. Total score is 100 which consists of 80 for test cases and 20 for documentation
3. Grading script provided by Pintos will be used.
 - **make grade** or **make check** in src/userprog
4. Refer to “grade” and “results” files in src/userprog/build after grading
 - “grade” file is only created when you use **make grade**
5. Test cases are classified in functionality / robustness / base file system (filesys base)
6. Refer to the followings for checking each test case’s point based on the test type
 - tests/userprog/Rubric.functionality
 - tests/userprog/Rubric.robustness
 - tests/filesys/base/Rubric

Evaluation: Test Cases (55 tests)

User Program

| Functionality | | |
|---------------|---------------|-------|
| No. | Name | Point |
| 1 | create-empty | 3 |
| 2 | create-long | 3 |
| 3 | create-normal | 3 |
| 4 | create-exists | 3 |
| 5 | open-missing | 3 |
| 6 | open-normal | 3 |
| 7 | open-twice | 3 |
| 8 | read-normal | 3 |
| 9 | read-zero | 3 |
| 10 | write-normal | 3 |

| Functionality | | |
|--------------------|----------------|-----------|
| No. | Name | Point |
| 11 | write-zero | 3 |
| 12 | close-normal | 3 |
| 13 | rox-simple | 3 |
| 14 | rox-child | 3 |
| 15 | rox-multichild | 3 |
| Total Score | | 45 |

Evaluation: Test Cases (55 tests)

User Program

| Robustness | | |
|------------|----------------|-------|
| No. | Name | Point |
| 1 | close-stdin | 2 |
| 2 | close-stdout | 2 |
| 3 | close-bad-fd | 2 |
| 4 | close-twice | 2 |
| 5 | read-bad-fd | 2 |
| 6 | read-stdout | 2 |
| 7 | write-bad-fd | 2 |
| 8 | write-stdin | 2 |
| 9 | multi-child-fd | 2 |
| 10 | create-bad-ptr | 3 |

| Robustness | | |
|------------|----------------|-------|
| No. | Name | Point |
| 11 | exec-bad-ptr | 3 |
| 12 | open-bad-ptr | 3 |
| 13 | read-bad-ptr | 3 |
| 14 | write-bad-ptr | 3 |
| 15 | create-bound | 3 |
| 16 | open-boundary | 3 |
| 17 | read-boundary | 3 |
| 18 | write-boundary | 3 |
| 19 | create-null | 2 |
| 20 | open-null | 2 |

| Robustness | | |
|--------------------|------------|-----------|
| No. | Name | Point |
| 21 | open-empty | 2 |
| 22 | bad-read | 1 |
| 23 | bad-read2 | 1 |
| 24 | bad-write | 1 |
| 25 | bad-write2 | 1 |
| 26 | bad-jump | 1 |
| Total Score | | 56 |

Evaluation

User Program

| No-vm | | |
|--------------------|-----------|----------|
| No. | Name | Point |
| 1 | multi-oom | 1 |
| Total Score | | 1 |

Filesys

| Base | | |
|------|---------------|-------|
| No. | Name | Point |
| 1 | sm-create | 1 |
| 2 | sm-full | 2 |
| 3 | sm-random | 2 |
| 4 | sm-seq-block | 2 |
| 5 | sm-seq-random | 3 |
| 6 | lg-create | 1 |
| 7 | lg-full | 2 |
| 8 | lg-random | 2 |
| 9 | lg-seq-block | 2 |
| 10 | lg-seq-random | 3 |

| Base | | |
|--------------------|------------|-----------|
| No. | Name | Point |
| 11 | syn-read | 4 |
| 12 | syn-write | 4 |
| 13 | syn-remove | 2 |
| Total Score | | 30 |

| | |
|------------------|----|
| # of Total Tests | 55 |
|------------------|----|

Evaluation

- **Total score:**

$$\left(\frac{\text{Functionality}}{45} \times 35 + \frac{\text{Robustness}}{56} \times 25 + \frac{\text{no-vm}}{1} \times 10 + \frac{\text{filesystem(base)}}{30} \times 30 \right) / 100 \times 80$$

- **Documentation**

- Use the document file uploaded on e-class.
- Documentation accounts for 20% of total score.
(Development 80%, Documentation 20%)

Submission

- Make 'ID' directory and copy 'src' directory' in the pintos directory and the document file ([ID].docx).
 - Compress 'ID' directory to '**os_prj2_[ID].tar.gz**'.
 - We provide the script 'submit.sh' to make tar.gz file which contains 'src' directory and document file.
학생들의 편의를 위해 pintos 디렉토리 내 submit.sh 스크립트를 제공합니다.
이 스크립트는 src 디렉토리와 document file을 포함한 tar.gz 파일을 생성합니다.
- **Disclaimer**
 - Any result produced from the 'submit.sh' script is at your own risk.
 - You must check the contents of the tar.gz file before submission.
 - 'submit.sh' 스크립트로 생성된 결과의 모든 책임은 사용자에게 귀속됩니다.
 - 제출하기 전, tar.gz 파일의 내용물을 반드시 다시 한 번 체크하기 바랍니다.

Submission

- **Notice – ‘submit.sh’**

- The ‘submit.sh’ script should be executed on a directory where ‘src’ folder is located.

submit.sh 스크립트는 src 폴더가 위치한 디렉토리에서 실행되어야 합니다.

- ‘ID’ folder should not be in the directory.

해당 디렉토리에 ‘학번’ 폴더가 없어야 합니다.

- ‘ID.docx’ file should be located in the directory.

Also, report file with extensions other than ‘docx’ will not be compressed.

해당 디렉토리에 ‘학번.docx’ 파일이 있어야 함께 압축됩니다.

또한 ‘docx’ 이외의 확장자를 가진 보고서 파일은 압축되지 않습니다.

- Be sure to backup your code in case of an unexpected situation.

만일의 경우를 대비해 반드시 코드를 백업하여 주세요.

Submission

- It is a **personal project**.
- Due date : 2025. 10. 29 23:59
- Submission

- The form of submission file is as follows:

| Name of compressed file | Example (ID: 20189999) |
|-------------------------|-------------------------|
| os_prj2_[ID].tar.gz | os_prj2_20189999.tar.gz |

- No hardcopy.
- **Copy will get a penalty (1st time: 0 Point and downgrading, 2nd time: F grade)**

Submission

- **Contents**

- ① Pintos source codes (Only '**src**' directory in pintos directory)
최소한의 용량을 위해 **src** 디렉토리만 압축파일에 포함합니다.
- ② Document: **[ID].docx** (e.g. 20189999.docx; Other format is not allowed such as .hwp)

- **How to submit**

- 1) Make tar.gz file.
 - Copy the document file ([ID].docx) to pintos directory.
 - Execute **submit.sh** script in the pintos directory and follow the instructions of the script.
pintos 디렉토리 내의 **submit.sh** 스크립트를 실행하고 스크립트의 지시를 따르십시오.
 - Check that **os_prj2_[ID].tar.gz** is created.
 - Decompress **os_prj2_[ID].tar.gz** and check the contents in it. (\$ **tar -zxf os_prj2_[ID].tar.gz**)
(Only **[ID].docx** and **src** directory should be contained in the tar.gz file.)
 - For example, if your ID is 20189999, **os_prj2_20189999.tar.gz** should be created.
To decompress the tar.gz file, execute **tar -zxf os_prj2_20189999.tar.gz**
 - **Please check the contents of tar.gz file after creating it.**
- 2) Upload the **os_prj2_[ID].tar.gz** file to e-class.

5% of point will be deducted for a wrong form and way to submit.

❖ Late submission is allowed up to 3 days (~11/01) and 10% of point will be deducted per day.