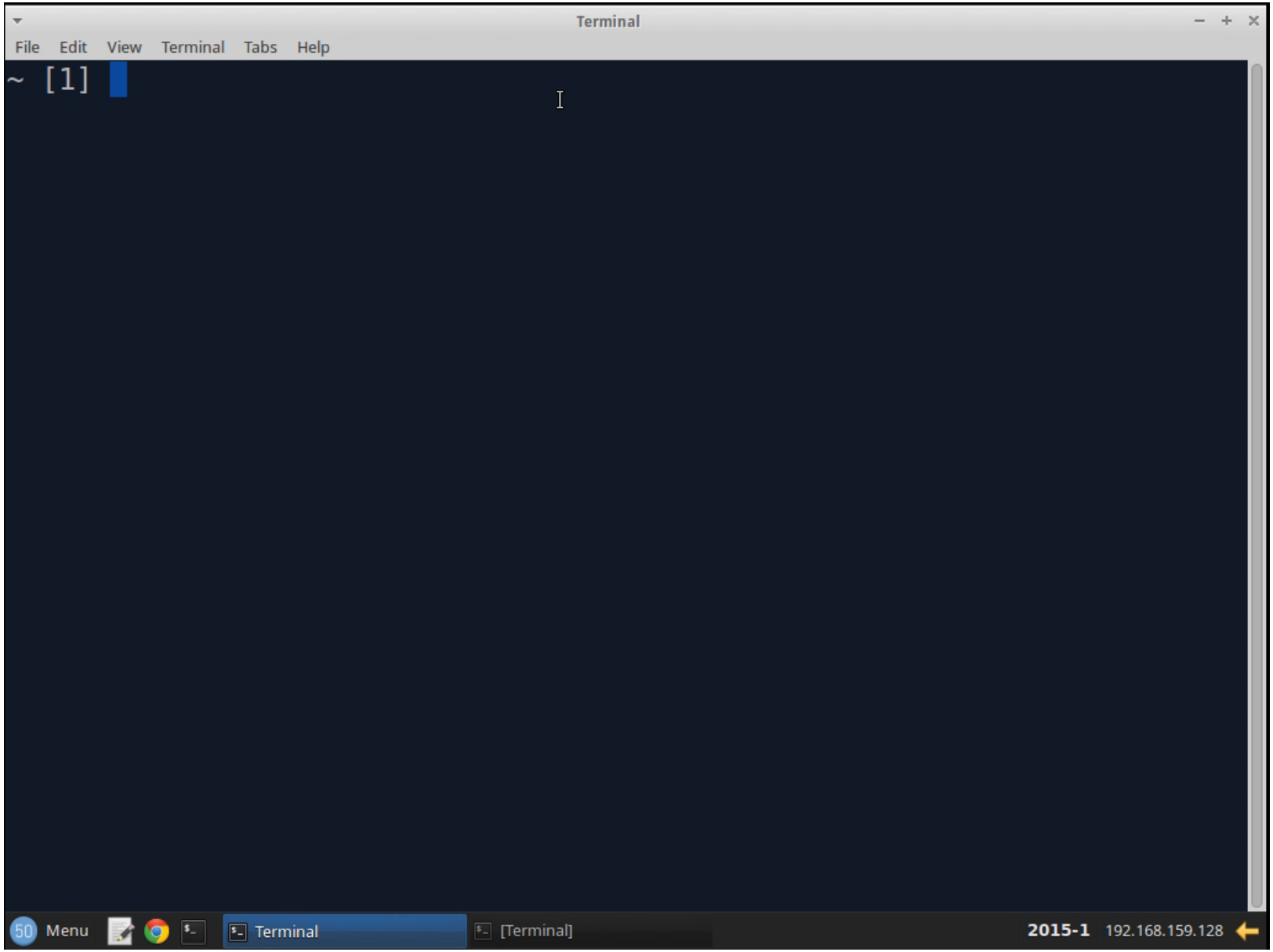
Mmap

- Learning Objectives
  - Use `mmap` (and it's associated calls).
  - Explain the relationship between `mmap` and caching.
  - Discuss the pros and cons of using `mmap`.


Terminal
File Edit View Terminal Tabs Help
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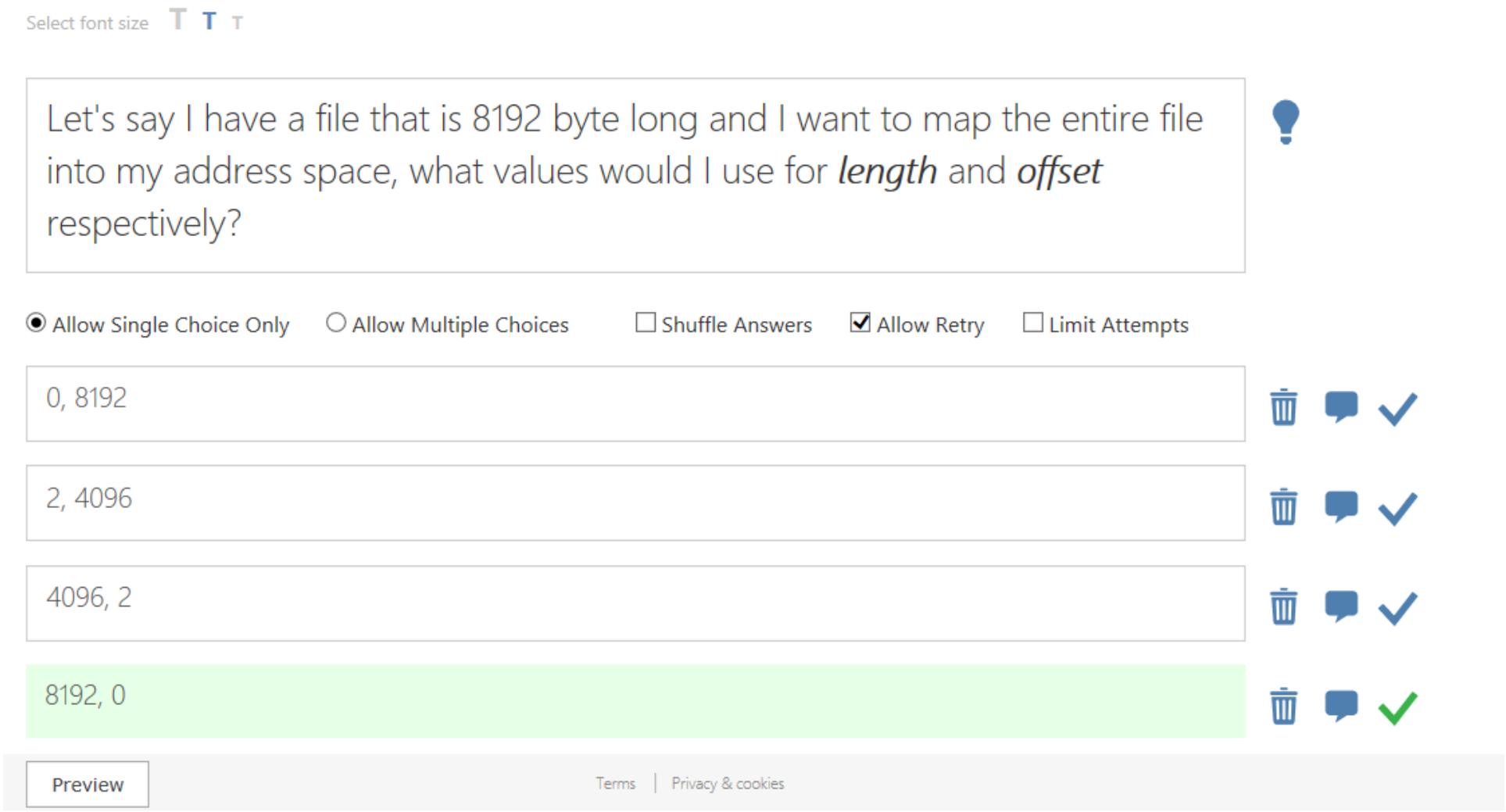
What is `mmap`?

- From the man page:

```
void *mmap(void *addr,
        size_t len, int prot, int flags,
        int fd, off_t offset);
```

  - `mmap()` creates a new mapping in the virtual address space of the calling process. The starting address for the new mapping is specified in **`addr`**. The **`length`** argument specifies the length of the mapping.
  - The `mmap()` system call causes the pages starting at **`addr`** and continuing for at most **`len`** bytes to be mapped from the object described by **`fd`**, starting at byte offset **`offset`**.


Select font size T T T
Let's say I have a file that is 8192 byte long and I want to map the entire file into my address space, what values would I use for *length* and *offset* respectively?
Allow Single Choice Only
Allow Multiple Choices
Shuffle Answers
Allow Retry
Limit Attempts
0, 8192
2, 4096
4096, 2
8192, 0
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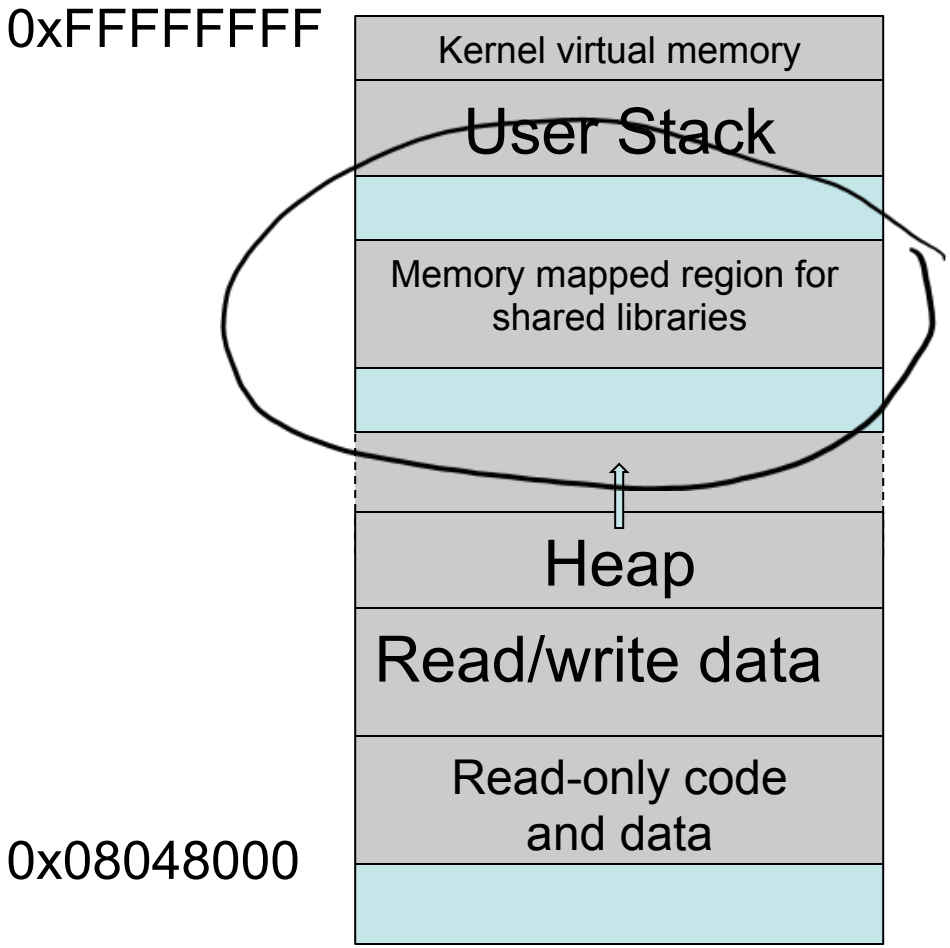
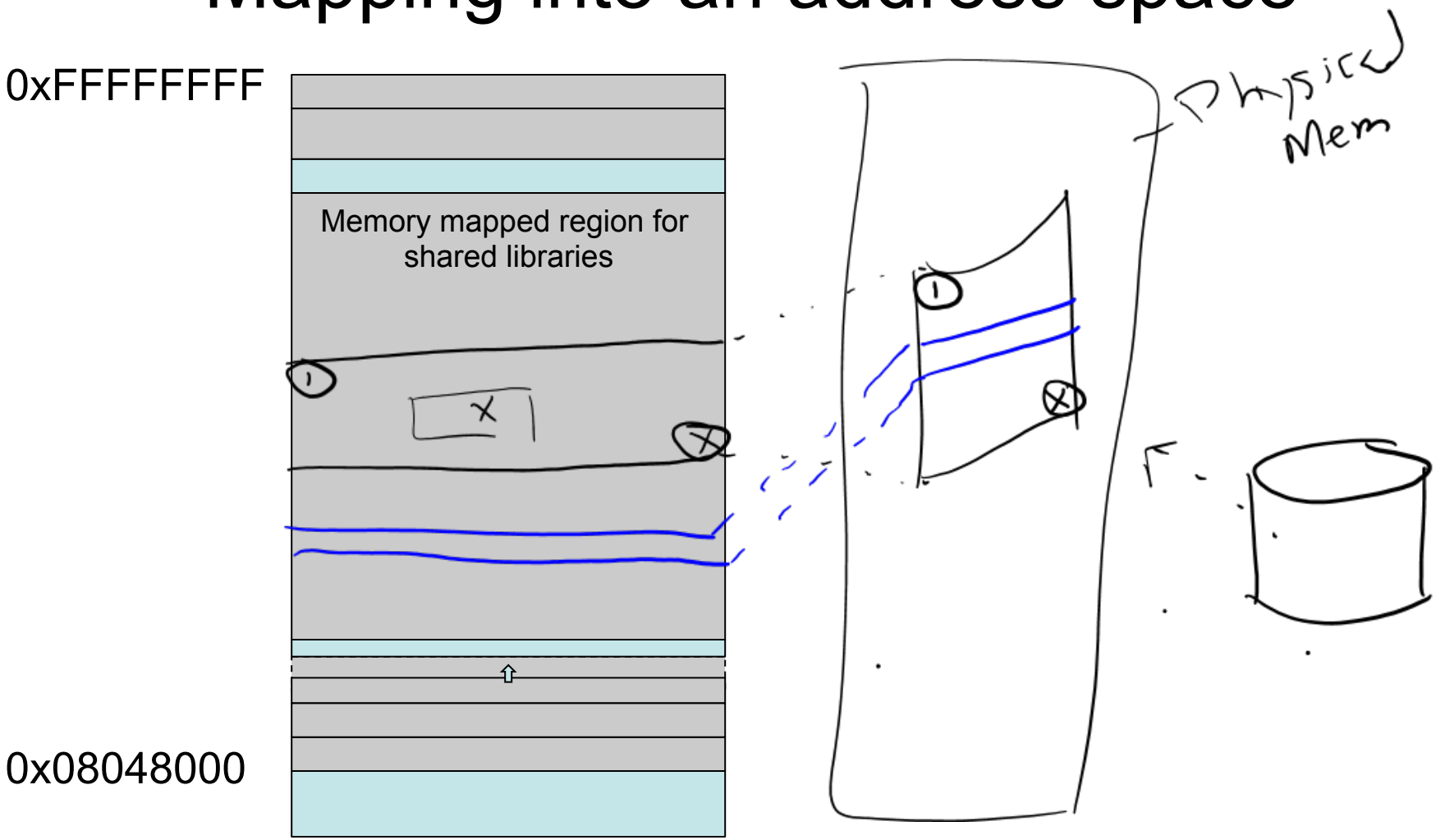
Recall our friend the address space

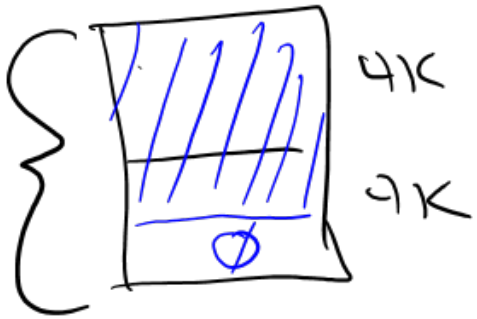


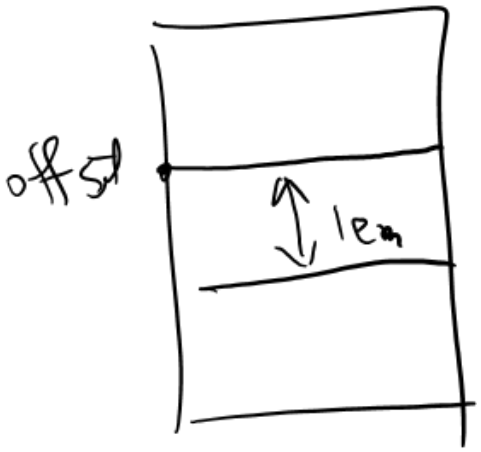
Mapping into an address space



`mmap`'s parameters (1)

- The obvious ones:
  - `fd`: a file descriptor representing the file you are mapping.
  - `len`: the number of bytes you are mapping.
  - `offset`: the position in the file at which to begin mapping.
  - Note: `len` and `offset` really should be multiples of the system's underlying page size.





`mmap`'s parameters (2)

- `flags`:
  - Exactly one of:
    - `MAP_SHARED`: Updates to the mapped file are visible to other processes and are written back to the file.
    - `MAP_PRIVATE`: Updates to the mapped file are not visible to other processes and are not written back to the file.
  - Optionally any of:
    - `MAP_32BIT`: Place the mapping in the first 2 GB of address space.
    - `MAP_ANON/MAP_ANONYMOUS`: Do not associate mapping with a file (`fd` and `offset` are ignored).
    - `MAP_FIXED`: Place the mapping at a specific place in the address space (specified by `addr` argument; else `addr` is ignored).
    - Many other Linux (and other specific) specific ones.

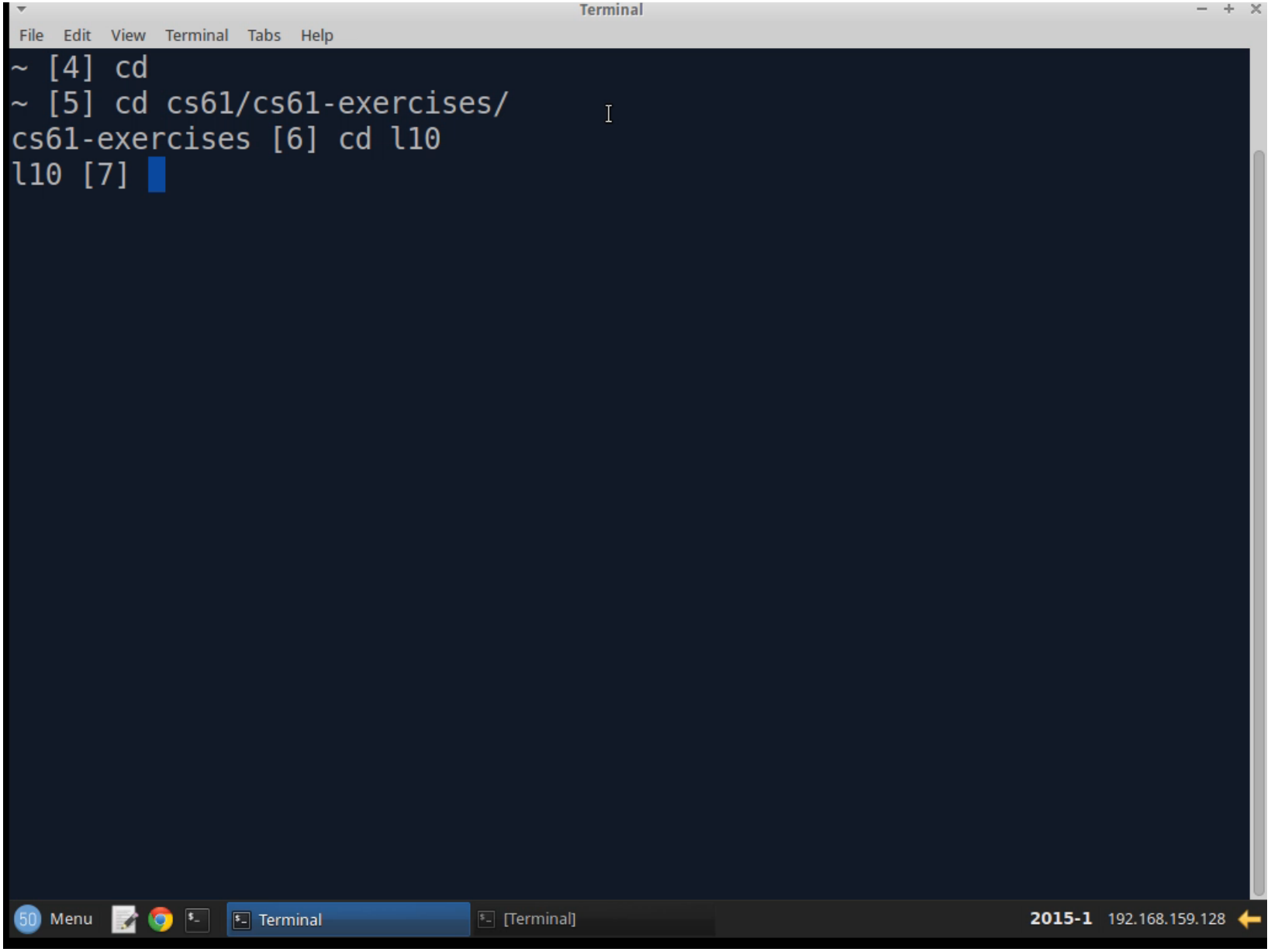
`mmap`'s parameters (3)

- `prot`:
  - Either:
    - `PROT_NONE`: pages may not be accessed
  - Or a bitwise combination of:
    - `PROT_EXEC`: pages may be executed
    - `PROT_READ`: pages may be read
    - `PROT_WRITE`: pages may be written
  - Must be consistent with open mode of `fd`.

Other Calls

- `int munmap(void *addr, size_t length);`
  - Delete the mapping starting at `addr`

- `int msync (void *addr, size_t length, int flags);`
  - Flushes changes made to the in-memory copy of the file to be reflected back to the disk (persistent store).


Terminal
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~ [4] cd
~ [5] cd cs61/cs61-exercises/
cs61-exercises [6] cd l10
l10 [7]
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Why `mmap`?

- You probably observed that mmap was quite fast, even faster than standard IO. Why?
  - Fewer system calls: you make only one system call to map the file; then the rest of the processing that the system has to do is a side-effect of simply touching memory.
  - Fewer copies: both standard IO and read/write copy the data out of the operating system into a user buffer. `mmap` brings the data into memory and lets your application access that data directly (in the read-only case).

Why not `mmap`?

- Why do we ever use read/write if mmap is so fast?
  - Can't really grow files easily using `mmap`, so it's not create for creating a new files.
  - Although `msync` lets you force data to persistent storage, the application has no control over when data may be flushed back to persistent storage, so it is difficult to maintain on-disk data consistency using `mmap` with updates.
  - Requires block-alignment – not great for small files.
  - Doesn't work on all file types (just regular files).