In this project, we made a read operations on a text file to be able to obtain number of occurrence of character ‘a’ with using three different methods. First one is a CPP file that uses fstream for reading the file, second one is a C file that uses fopen for reading the file, and third one is a C file that utilizes memory mapping with mmap function on the file.

First one and second one (fstream/fopen) are nearly same things, the biggest differences is language that we used (as we learnt C is more low-level) (other little differences will be given in the following sections). On the other hand, third one, which is memory mapping, is a different method.

Advantages of memory mapping:

- Reading from and writing to a memory-mapped file avoids the extraneous copy that occurs when using the read()/write() system calls, where the data must be copied to and from a user-space buffer. (from stackoverflow.com)
- Memory maps are generally faster for random access.
- Memory maps allow us to keep using pages from the cache until we are done (from stackoverflw.com). This means that if we use a file heavily for a long period of time, then close it and reopen it, the pages will still be cached.
- Reading a file is very simple and fast.
- Useful for interprocess communication.
- Better for large files.

Disadvantages of memory mapping:

- There might not be enough address space to map it.
- There can be problem when address space is fragmented because, memory mapping has to find contiguous block in process's address space that is large enough to fit the entire range of the file being mapped. We can solve it with mapping the file in smaller chunks.
- “For small files, a significant percentage of the mapping may be wasted. For example, with 4 KB pages, a 7 byte mapping wastes 4,089 bytes.” (directly from stackoverlfow.com).

Advantages of fstream/fopen:

- We are familiar with :)
- Better for small files. As we see, in memory mapping, significant percentage of the mapping may be wasted.

Disadvantages of fstream/fopen:

- Not time efficient for large files compared to mmap().

Advantages of fstream over fopen: fstream is more secure.

Advantages of fopen over fstream: fopen is faster in small files

Memory mapping is faster method compared to other two which means that it uses time more efficiently (in large files). Because as we saw in recitation, mmap() function is used for mapping between a process address space and either files or devices, when a file is mapped to a

process address space, the file can be accessed like an array in the program and this is one of the most efficient ways to access data in the file.

As we discussed, for small files fstream/fopen performs better, on the other hand, for large files, memory mapping performs better.