

## Assignment 5 – Buffered I/O

### Description:

This assignment involves writing a C program designed to copy a specified number of bytes from a provided file. Upon receiving the byte count, the program opens the file and populates the buffer provided with the data.

### Approach:

Before working with any of the functions, I need to think about the `b_fcb` struct in order to think about how to keep track of the file that we are opening. Similar to assignment two, where we read strings into our buffer, we need to create a buffer of `B_CHUNK_SIZE` bytes and keep track of the position in our buffer, the remaining space, and how many bytes have been read.

The first function `b_open` should be fairly simple to implement, given that we have two big hints that we are supposed to use `GetFileInfo` and `b_getFCB`. Using the return values from these, we simply initialize our FCB instance and create our buffer of `B_CHUNK_SIZE` and set our starting position and bytes read to zero. Then, place it into `fcbArray` and return the file descriptor, as mentioned in the README.

Then, we need to read the data to our buffer in `b_read`. Basically, this was kind of like what we did in assignment two, except there's a couple more things we need to keep track of. Since we are reading at most `count`, we first need to check if we are at the end of file as hinted in the comments. If this is the case, we need to adjust the number of bytes that we are going to be reading in by checking if the bytes read so far plus the count have exceeded the file size.

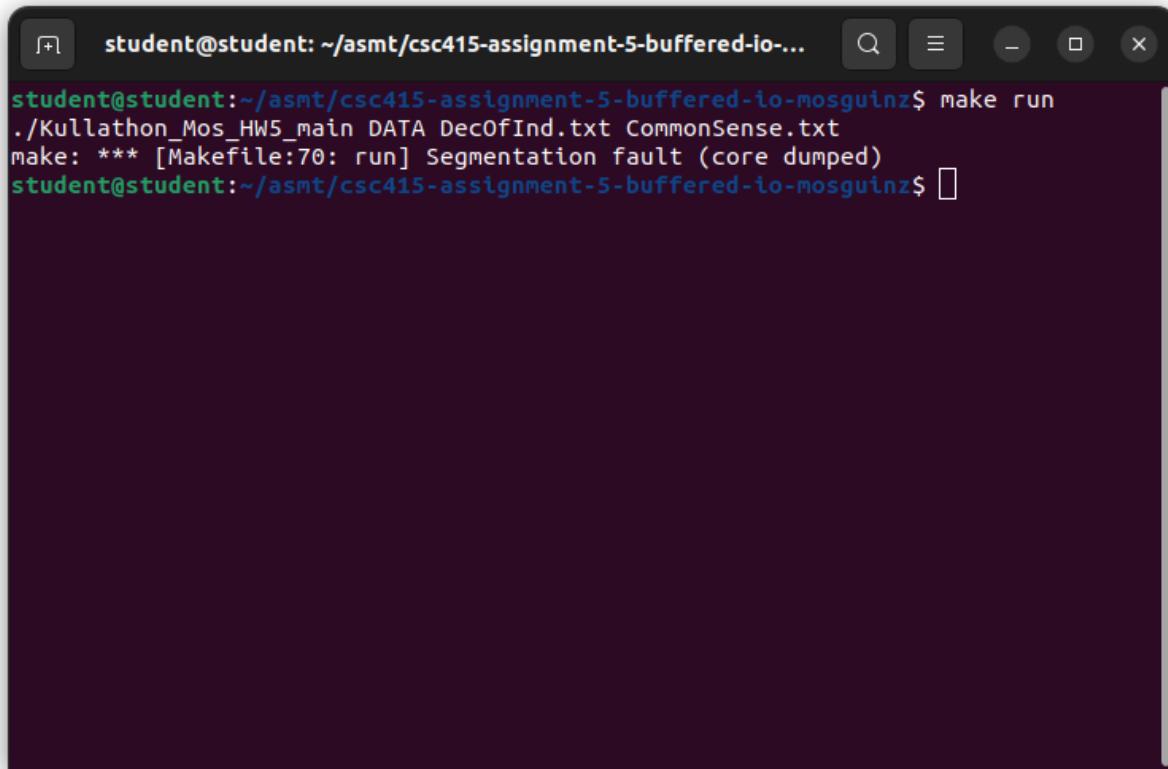
Keeping track of the number of bytes read so far, we loop until we have read the requested amount and simply copy the remaining bytes into our buffer using `memcpy` and then update the start positions, remaining bytes to be read, and the amount read so far. Then, we want to call `LBRead` only when we can no longer write to our buffer so that we do not unnecessarily read the file if we already have the data needed.

Finally at the end, we just update the number of bytes read and return the total number of bytes that we've read.

In `b_close`, we just need to free the buffer that we created and set the file info field in the corresponding field descriptors to be null.

### Issues and Resolutions:

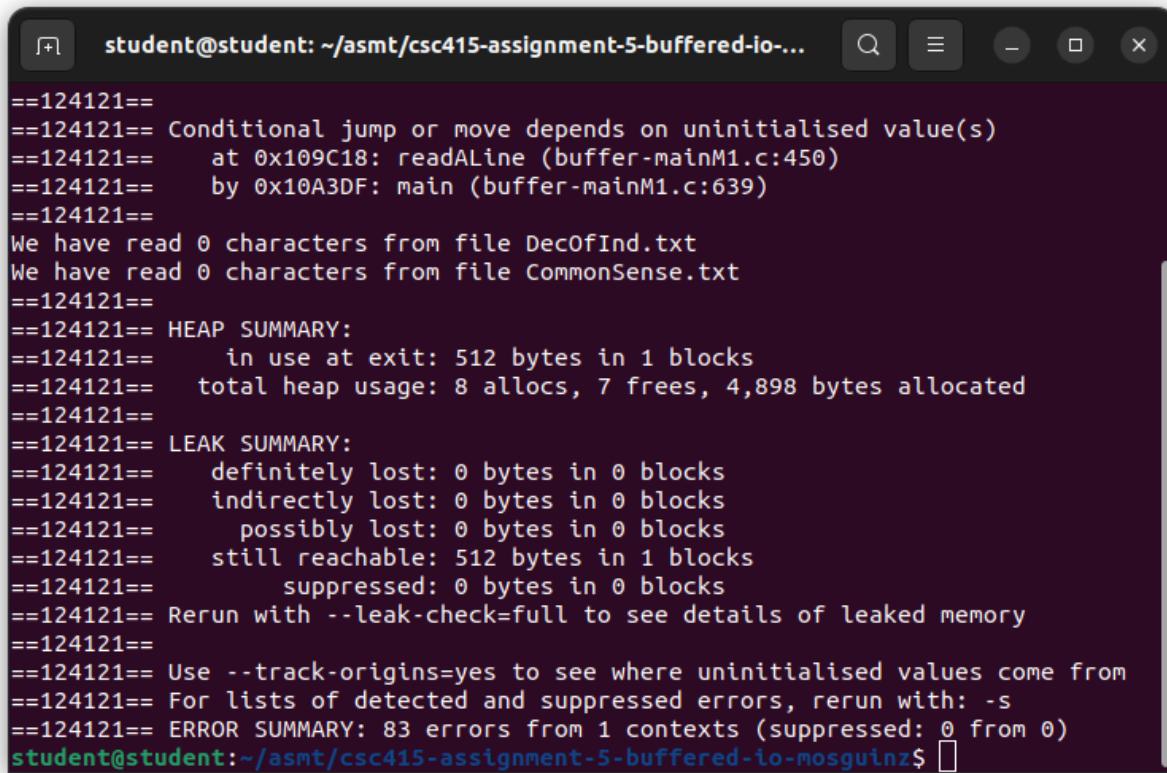
Issue one: segfaulting right off the bat!!! This issue took me a while to found, all I needed to do was ensure that the return value from `GetFileInfo` is actually valid. I didn't see that it returns null when the file is not found, so I handled it with a simple if-statement in `b_open`.



A screenshot of a terminal window titled "student@student: ~/asmt/csc415-assignment-5-buffered-io-...". The terminal shows the command "make run" being executed. The output indicates a segmentation fault (core dumped) at line 70 of the Makefile. The terminal has a dark background and light-colored text.

```
student@student:~/asmt/csc415-assignment-5-buffered-io-mosguinz$ make run
./Kullathon_Mos_HW5_main DATA DecOfInd.txt CommonSense.txt
make: *** [Makefile:70: run] Segmentation fault (core dumped)
student@student:~/asmt/csc415-assignment-5-buffered-io-mosguinz$
```

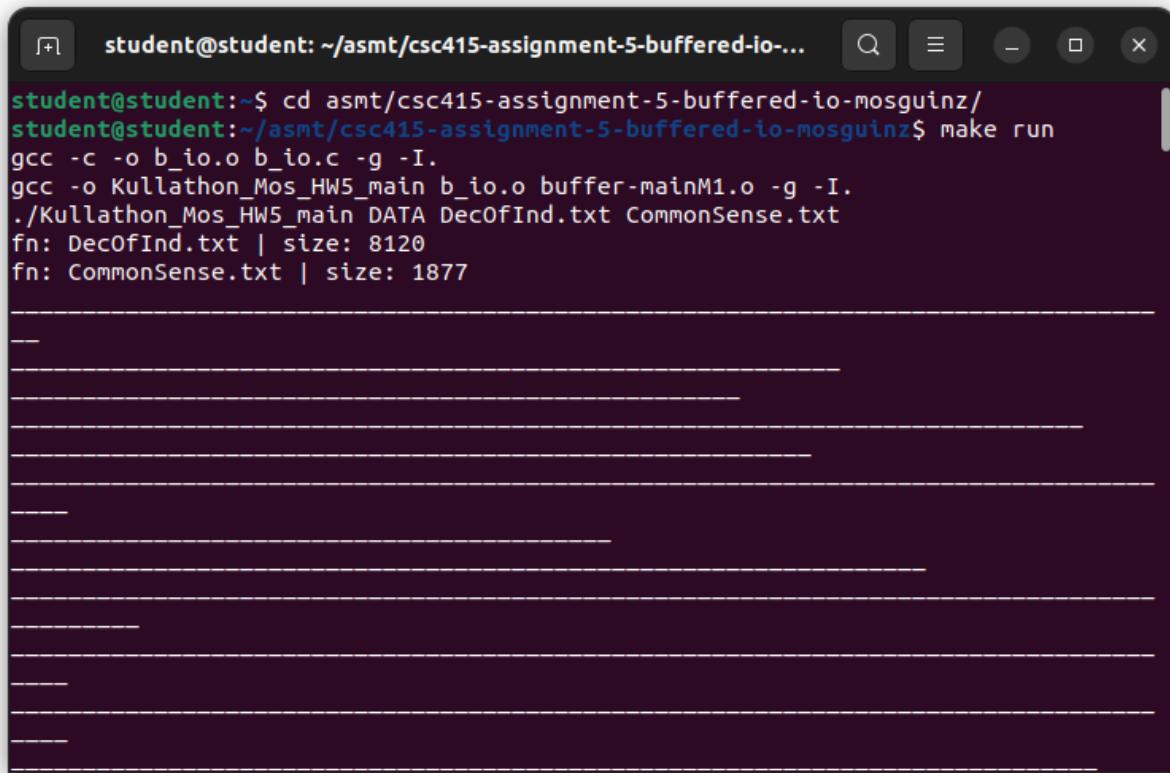
Issue one: unexplained memory leak. When I need to `malloc` (or call anything that does that), I usually centralize all of them in a single function, so that I know exactly what needs to be freed at the end. Here, the *only* thing that I can think of `malloc`-ing is the buffer in my FCB, which is done in `b_open`. Correspondingly, I free it in `b_close`. I always check if there is a leak before adding more code — right from the start when I designed the `b_fcb` struct. But for some reason, there is always one alloc that isn't being freed and I have no idea why.



A screenshot of a terminal window titled "student@student: ~/asmt/csc415-assignment-5-buffered-io-...". The window contains Valgrind output. The output includes several error messages, notably conditional jumps and moves depending on uninitialized values at specific memory addresses. It also provides a HEAP SUMMARY and a LEAK SUMMARY, both of which show zero bytes lost or suppressed. A final message suggests rerunning with --leak-check=full for more details. The command "student@student:~/asmt/csc415-assignment-5-buffered-io-mosguinz\$" is visible at the bottom.

```
==124121== Conditional jump or move depends on uninitialized value(s)
==124121==   at 0x109C18: readALine (buffer-mainM1.c:450)
==124121==   by 0x10A3DF: main (buffer-mainM1.c:639)
==124121== 
==124121== We have read 0 characters from file DecOfInd.txt
==124121== We have read 0 characters from file CommonSense.txt
==124121== 
==124121== HEAP SUMMARY:
==124121==   in use at exit: 512 bytes in 1 blocks
==124121==   total heap usage: 8 allocs, 7 frees, 4,898 bytes allocated
==124121== 
==124121== LEAK SUMMARY:
==124121==   definitely lost: 0 bytes in 0 blocks
==124121==   indirectly lost: 0 bytes in 0 blocks
==124121==   possibly lost: 0 bytes in 0 blocks
==124121==   still reachable: 512 bytes in 1 blocks
==124121==     suppressed: 0 bytes in 0 blocks
==124121== Rerun with --leak-check=full to see details of leaked memory
==124121== 
==124121== Use --track-origins=yes to see where uninitialized values come from
==124121== For lists of detected and suppressed errors, rerun with: -s
==124121== ERROR SUMMARY: 83 errors from 1 contexts (suppressed: 0 from 0)
student@student:~/asmt/csc415-assignment-5-buffered-io-mosguinz$
```

Issue two: dashes being printed at the start. When I initialized the FCB in `b_open`, I did simply set the block number to the starting LBA. To fix this issue, I simply needed to call `LBAread` as well in `b_open` to read the first block.



A screenshot of a terminal window titled "student@student: ~/asmt/csc415-assignment-5-buffered-io-...". The window shows the following command-line session:

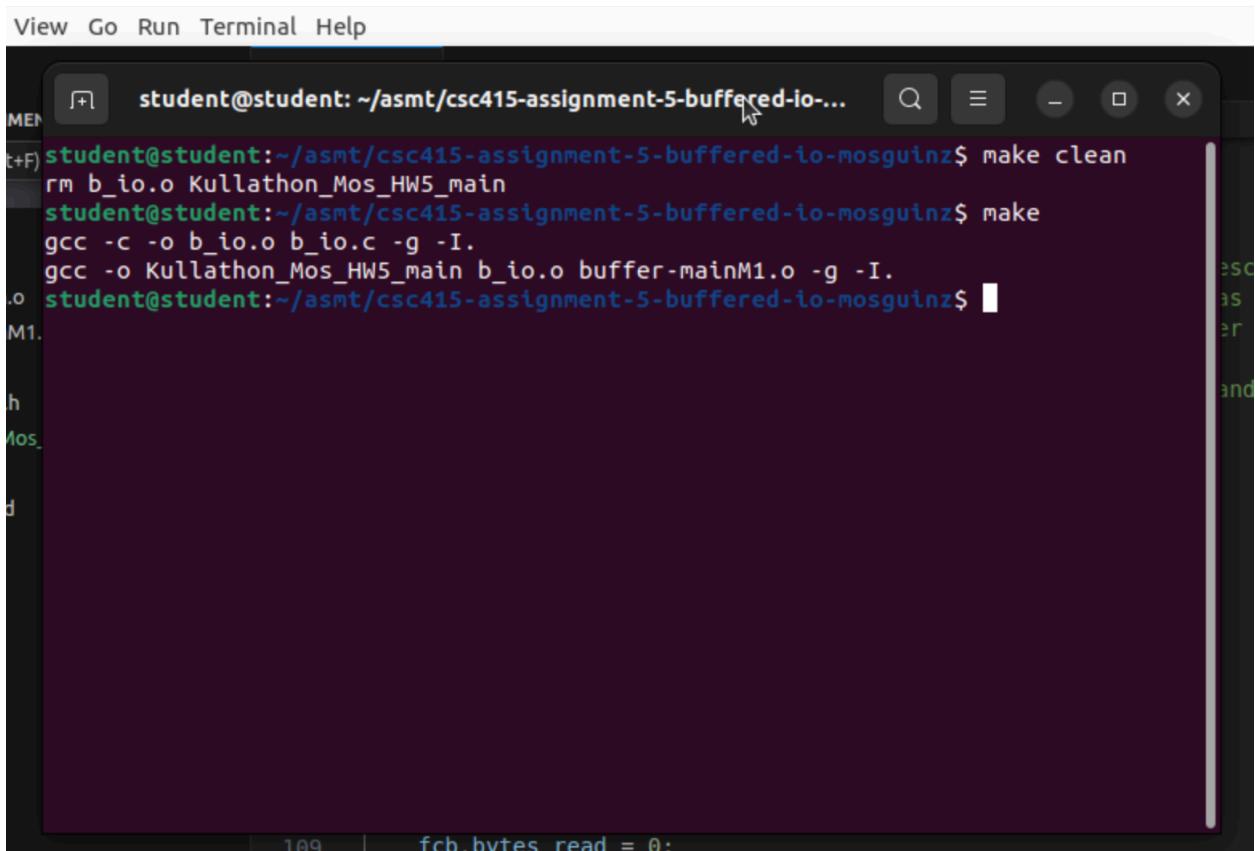
```
student@student:~$ cd asmt/csc415-assignment-5-buffered-io-mosguinz/
student@student:~/asmt/csc415-assignment-5-buffered-io-mosguinz$ make run
gcc -c -o b_io.o b_io.c -g -I.
gcc -o Kullathon_Mos_HW5_main b_io.o buffer-mainM1.o -g -I.
./Kullathon_Mos_HW5_main DATA DecOfInd.txt CommonSense.txt
fn: DecOfInd.txt | size: 8120
fn: CommonSense.txt | size: 1877
```

The terminal has a dark background and light-colored text. It features standard OS X-style window controls at the top right.

### Analysis:

N/A

Screen shot of compilation:



A screenshot of a terminal window titled "student@student: ~/asmt/csc415-assignment-5-buffered-io-...". The terminal shows the following command sequence:

```
student@student:~/asmt/csc415-assignment-5-buffered-io-mosguinz$ make clean
rm b_io.o Kullathon_Mos_HW5_main
student@student:~/asmt/csc415-assignment-5-buffered-io-mosguinz$ make
gcc -c -o b_io.o b_io.c -g -I.
gcc -o Kullathon_Mos_HW5_main b_io.o buffer-mainM1.o -g -I.
.o student@student:~/asmt/csc415-assignment-5-buffered-io-mosguinz$
```

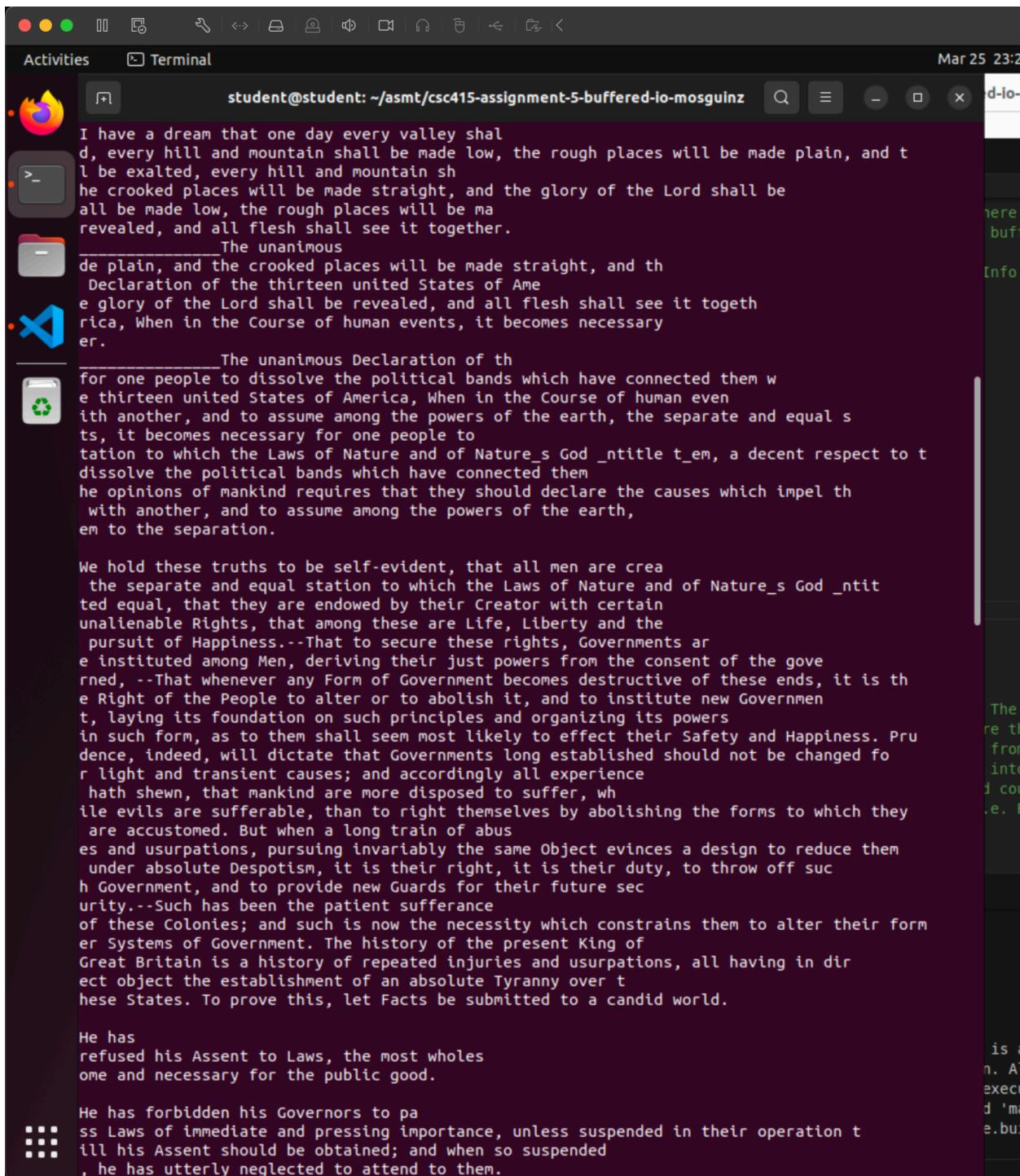
The terminal window has a dark background and light-colored text. The title bar and menu bar are visible at the top. The bottom of the window shows a status bar with the number "109" and the text "fcb.bytes read = 0:".

Screen shot(s) of the execution of the program:

```
student@student:~/asmt/csc415-assignment-5-buffered-io-mosguinz$ make
gcc -c -o b_io.o b_io.c -g -I.
gcc -o Kullathon_Mos_HW5_main b_io.o buffer-mainM1.o -g -I.
student@student:~/asmt/csc415-assignment-5-buffered-io-mosguinz$ make run
./Kullathon_Mos_HW5_main DATA DecOfInd.txt CommonSense.txt
The unanimous Declaration of the thirteen united States of America, When
Perhaps the sentiments contained in the follow
in the Course of human events, it becomes necessary for one people to dissolve the po
ing pages, are not yet
sufficiently fashionable to procure
litical bands which have connected them with another, and to as
them general favor; a long habit
of not thinking a thing wrong, gives it a sup
sume among the powers of the earth, the separate and equal s
erficial appearance of
being right, and raises at first a formida
tation to which the Laws of Nature and of Nature_s God _ntitle t_em, a d
outcry in defense of
custom. But the tumult soon subsides. Time makes
ecent respect to the opinions of mankind requires that they sh
more converts than
reason.

As a long and violent abuse of powe
ould declare the causes which impel them to the separation.

We hold these truth
r, is generally the Means of calling
the right of it in question (and in Mat
s to be self-evid brotherhood.
I have a dream that one day even the state of Mississippi, a desert state, sweltering with the
heat of injustice and oppression, will be transformed into an oasis of freedom and justice.
I have a dream that my four children will one day live in a nation where they will not be judg
ed by the color of their skin but by the content of their character.
I have a dream today.
I have a dream that one day the state of Alabama, whose governor's lips are presently dripping
with the words of interposition and nullification, will be transformed into a situation where
little black boys and black girls will be able to join hands with
ters too which might never have
been thought brotherhood.
I have a dream that one day even the state of Mississippi, a desert state, sweltering with the
heat of injustice and oppression, will be transformed into an oasis of freedom and justice.
I have a dream that my four children will one day live in a nation where they will not be judg
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with the words of interposition and nullification, will be transformed into a situation where
little black boys and black girls will be able to join ha
little white boys and white girls and walk together as sisters and brothe
nds with little white boys and white girls and walk together as sisters and brother
rs.
I have a dream today.
I have a dream that one day every valley shall be exalte
s.
I have a dream today.
I have a dream that one day every valley shal
```



A screenshot of a Linux desktop environment showing a terminal window. The terminal window title is "student@student: ~/asmt/csc415-assignment-5-buffered-io-mosguinz". The terminal shows several blocks of text, likely from the Declaration of Independence, displayed in a monospaced font. The desktop background is visible, showing icons for a file manager, terminal, and other applications.

```
I have a dream that one day every valley shall
d, every hill and mountain shall be made low, the rough places will be made plain, and t
l be exalted, every hill and mountain sh
he crooked places will be made straight, and the glory of the Lord shall be
all be made low, the rough places will be ma
revealed, and all flesh shall see it together.

The unanimous
de plain, and the crooked places will be made straight, and th
Declaration of the thirteen united States of Ame
e glory of the Lord shall be revealed, and all flesh shall see it togeth
rica, When in the Course of human events, it becomes necessary
er.

The unanimous Declaration of th
for one people to dissolve the political bands which have connected them w
e thirteen united States of America, When in the Course of human even
ith another, and to assume among the powers of the earth, the separate and equal s
ts, it becomes necessary for one people to
tation to which the Laws of Nature and of Nature_s God _ntitle t_em, a decent respect to t
dissolve the political bands which have connected them
he opinions of mankind requires that they should declare the causes which impel th
with another, and to assume among the powers of the earth,
em to the separation.

We hold these truths to be self-evident, that all men are crea
the separate and equal station to which the Laws of Nature and of Nature_s God _ntit
ted equal, that they are endowed by their Creator with certain
unalienable Rights, that among these are Life, Liberty and the
pursuit of Happiness.--That to secure these rights, Governments ar
e instituted among Men, deriving their just powers from the consent of the gove
rned, --That whenever any Form of Government becomes destructive of these ends, it is th
e Right of the People to alter or to abolish it, and to institute new Governmen
t, laying its foundation on such principles and organizing its powers
in such form, as to them shall seem most likely to effect their Safety and Happiness. Pru
dence, indeed, will dictate that Governments long established should not be changed fo
r light and transient causes; and accordingly all experie
hath shewn, that mankind are more disposed to suffer, wh
ile evils are sufferable, than to right themselves by abolishing the forms to which they
are accustomed. But when a long train of abus
es and usurpations, pursuing invariably the same Object evinces a design to reduce them
under absolute Despotism, it is their right, it is their duty, to throw off suc
h Government, and to provide new Guards for their future sec
urity.--Such has been the patient sufferance
of these Colonies; and such is now the necessity which constrains them to alter their former
Systems of Government. The history of the present King of
Great Britain is a history of repeated injuries and usurpations, all having in di
rect object the establishment of an absolute Tyranny over t
hese States. To prove this, let Facts be submitted to a candid world.

He has
refused his Assent to Laws, the most wholesome
and necessary for the public good.

He has forbidden his Governors to pa
ss Laws of immediate and pressing importance, unless suspended in their operation t
ill his Assent should be obtained; and when so suspended
, he has utterly neglected to attend to them.
```

The screenshot shows a Linux desktop environment with a terminal window open. The terminal window has a dark background and light-colored text. It displays a scrollback buffer containing a list of grievances, likely from the Declaration of Independence. The grievances are listed in numbered points, each starting with 'He has...'. The terminal window is titled 'Terminal' and shows the command 'student@student: ~/asmt/csc415-assignment-5-buffered-io-mosguinz'. The desktop interface includes a dock with icons for a browser, file manager, terminal, and code editor, and a system tray with various icons.

```
student@student: ~/asmt/csc415-assignment-5-buffered-io-mosguinz
, he has utterly neglected to attend to them.

He has refused to pass other Laws for the accommodation of large districts of people, unless those people would relinquish the right of Representation in the Legislature, a right inestimable to them and formidable to tyrants only.

He has called together legislative bodies at places unusual, uncomfortable, and distant from the depository of their public Records, for the sole purpose of fatiguing them into compliance with his measures.

He has dissolved Representative Houses repeatedly, for opposing with manly firmness his invasions on the rights of the people.

He has refused for a long time, after such dissolutions, to cause others to be elected; where by the Legislative powers, incapable of Annihilation, have returned to the People at large for their exercise; the State remaining in the mean time exposed to all the dangers of invasion from without, and convulsions within.

He has endeavoured to prevent the population of these States; for that purpose obstructing the Laws for Naturalization of Foreigners; refusing to pass others to encourage their migrations hither, and raising the conditions of new Appropriations of Lands.

He has obstructed the Administration of Justice, by refusing his Assent to Laws for establishing Judiciary powers.

He has made Judges dependent on his Will alone, for the tenure of their offices, and the amount and payment of their salaries.

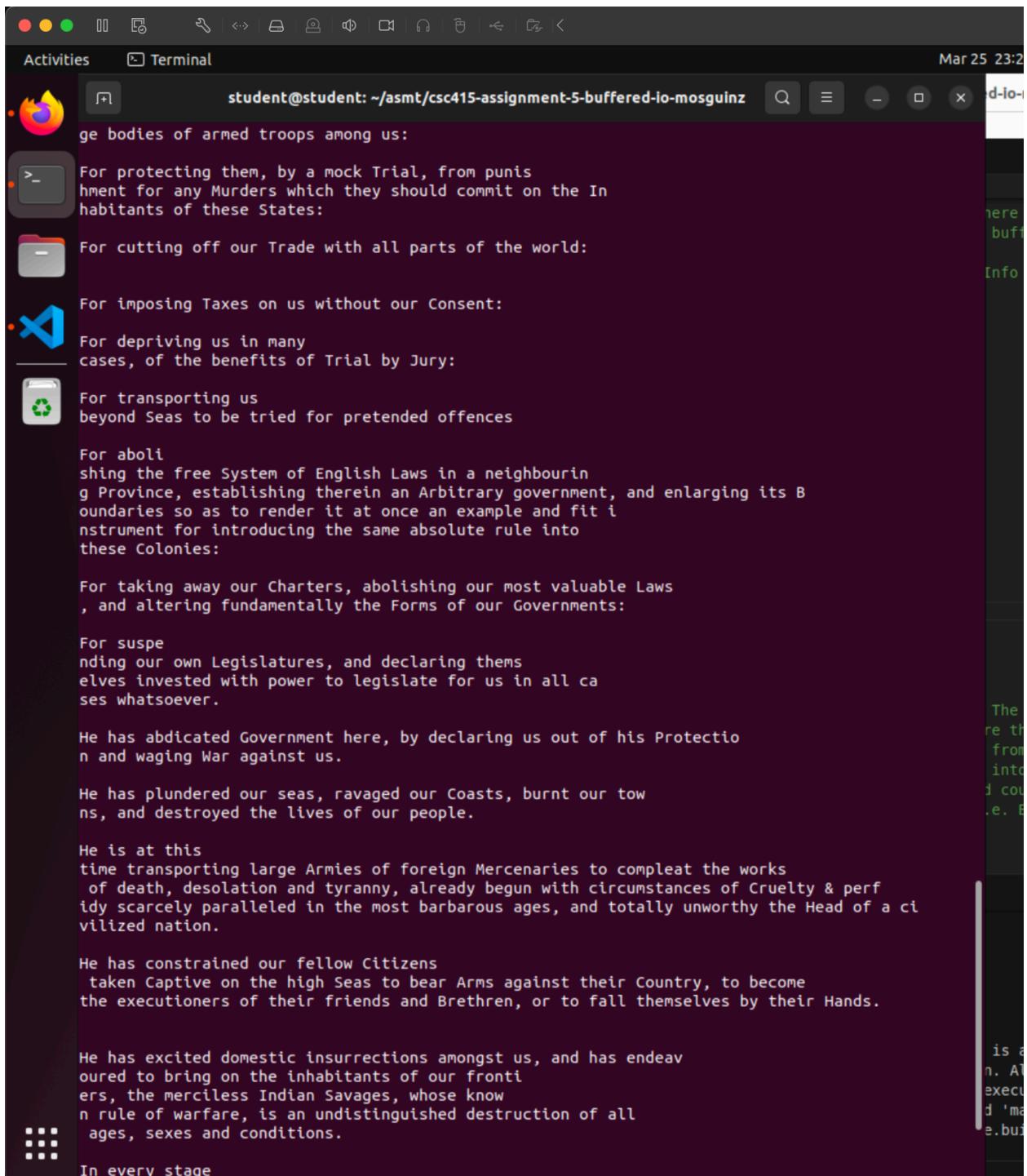
He has erected a multitude of New Offices, and sent hither swarms of Officers to harass our people, and eat out their substance.

He has kept among us, in times of peace, Standing Armies without the Consent of our legislatures.

He has affected to render the Military independent of and superior to the Civil power.

He has combined with others to subject us to a jurisdiction foreign to our Constitution, and unacknowledged by our laws; giving his Assent to their Acts of pretended Legislation;

For Quartering large bodies of armed troops among us:
```



The screenshot shows a Linux desktop environment with a terminal window open. The terminal window has a dark background and displays a scrollback buffer of text. The text is a historical document, likely the Declaration of Independence, listing grievances against King George III. The terminal window is titled "student@student: ~/asmt/csc415-assignment-5-buffered-io-mosguinz". The desktop interface includes a dock with icons for various applications like a browser, file manager, and terminal, and a system tray at the top.

```
student@student: ~/asmt/csc415-assignment-5-buffered-io-mosguinz
ge bodies of armed troops among us:
For protecting them, by a mock Trial, from punishment for any Murders which they should commit on the Inhabitants of these States:
For cutting off our Trade with all parts of the world:
For imposing Taxes on us without our Consent:
For depriving us in many cases, of the benefits of Trial by Jury:
For transporting us beyond Seas to be tried for pretended offences
For abolishing the free System of English Laws in a neighbouring Province, establishing therein an Arbitrary government, and enlarging its Boundaries so as to render it at once an example and fit instrument for introducing the same absolute rule into these Colonies:
For taking away our Charters, abolishing our most valuable Laws, and altering fundamentally the Forms of our Governments:
For suspending our own Legislatures, and declaring themselves invested with power to legislate for us in all cases whatsoever.
He has abdicated Government here, by declaring us out of his Protection and waging War against us.
He has plundered our seas, ravaged our Coasts, burnt our towns, and destroyed the lives of our people.
He is at this time transporting large Armies of foreign Mercenaries to compleat the works of death, desolation and tyranny, already begun with circumstances of Cruelty & perfidy scarcely paralleled in the most barbarous ages, and totally unworthy the Head of a civilized nation.
He has constrained our fellow Citizens taken Captive on the high Seas to bear Arms against their Country, to become the executioners of their friends and Brethren, or to fall themselves by their Hands.
He has excited domestic insurrections amongst us, and has endeavoured to bring on the inhabitants of our frontiers, the merciless Indian Savages, whose known rule of warfare, is an undistinguished destruction of all ages, sexes and conditions.
In every stage
```

```
For depriving us in many cases, of the benefits of Trial by Jury:
```

```
For transporting us beyond Seas to be tried for pretended offences
```

```
For abolishing the free System of English Laws in a neighbouring Province, establishing therein an Arbitrary government, and enlarging its Boundaries so as to render it at once an example and fit Instrument for introducing the same absolute rule into these Colonies:
```

```
For taking away our Charters, abolishing our most valuable Laws, and altering fundamentally the Forms of our Governments:
```

```
For suspending our own Legislatures, and declaring themselves invested with power to legislate for us in all cases whatsoever.
```

```
He has abdicated Government here, by declaring us out of his Protection and waging War against us.
```

```
He has plundered our seas, ravaged our Coasts, burnt our towns, and destroyed the lives of our people.
```

```
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```

```
He has constrained our fellow Citizens taken Captive on the high Seas to bear Arms against their Country, to become the executioners of their friends and Brethren, or to fall themselves by their Hands.
```

```
He has excited domestic insurrections amongst us, and has endeavoured to bring on the inhabitants of our frontiers, the merciless Indian Savages, whose known rule of warfare, is an undistinguished destruction of all ages, sexes and conditions.
```

```
In every stage of these Oppressions We have Petitioned for Redress in the most humble terms: Our repeated Petitions have been answered only by repeated Injury. A Prince whose character is thus marked by every act which may define a Tyrant, is unfit to be the ruler of a free people.
```

```
Nor have We been wanting in attention to our Brittish brethren. We have warned them from time to time of attempts by the We have read 8120 characters from file DecOfInd.txt  
We have read 1877 characters from file CommonSense.txt
```

student@student:~/asmt/csc415-assignment-5-buffered-io-mosguinz\$