

Assignment 5 – Buffered I/O Read

Description:

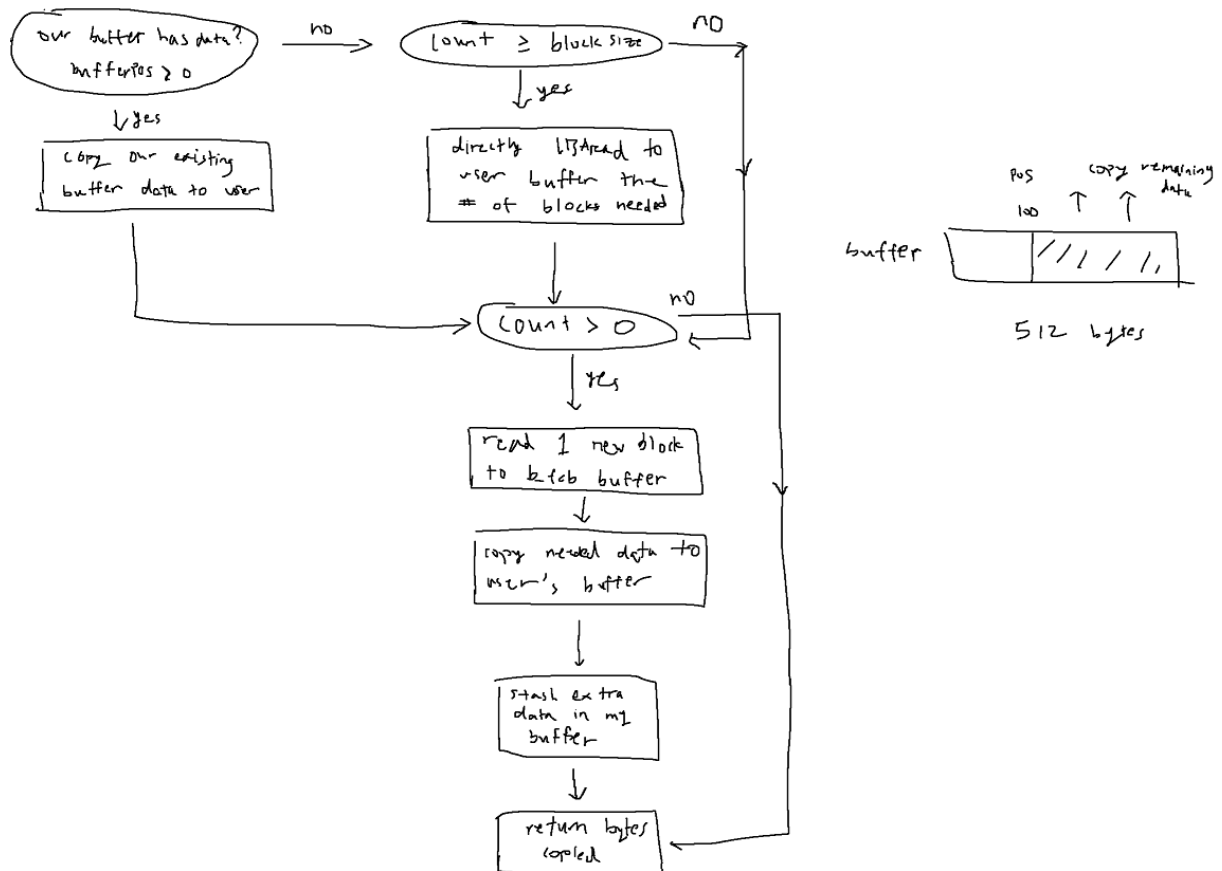
This program handles the basic buffered file operations: open, read, and close. The buffered read function processes the file's content in blocks, returning the specified amount of data the caller requests.

Approach:

Before approaching any functions, I need to add variables I will use into the `b_fcb` structure. I will first add a `char*` buffer to store the excess data that I cannot directly copy to the caller's buffer. Since we can only copy a block at a time, I cannot discard the remaining data obtained from calling `LBaread`. The other variable I need will be a buffer position (index) to track how much of our buffer data I have transferred to the caller's buffer. I will need an integer variable in the file position to track how many bytes we have read from the file, which helps calculate the end of the file. The last variable I will need is an integer variable that tracks the block offset from the starting position of the file location (returned by `fileInfo` location). The offset tracker allows me to keep track of which file blocks I am currently at and only read the next block on the next `LBaread` call.

After populating the structure, I will need to implement the `b_open` function, which will be relatively straightforward. In this function, I will call `GetFileInfo` to retrieve the file information and `b_getFCB()` to get a free file control block (file descriptor). The next step is to instantiate my buffer with `B_CHUNK_SIZE`. Lastly, I will populate my `fcArray` with the file information at the corresponding file descriptor index and set the tracking variables to zero.

Now, for the main part of the program, the `b_read` function, I will be following the following diagram I created (next page):



There will be three cases I need to consider in the read function:

1. Is there data in our buffer?
2. Can we directly read the file's content into the caller's buffer?
3. Are there still bytes we need to copy to the caller?

In the first case, I will copy the existing data in my buffer to the caller's buffer. In a sense, I am clearing my buffer in the `b_fcb` structure. If the requested amount exceeds the available data in my buffer, I will copy the existing data and handle the remainder of the request in the third case. If the requested amount doesn't exceed our data, then GREAT; I can save the remaining data for the next time the `b_read` call.

For the second case, where the requested amount exceeds the block size, I can directly read the file content into the caller's buffer. I will first calculate how many data blocks can fit into the caller's requested amount. This approach allows me to call `LBaread` just once, rather than multiple times, reading the file content block by block. However, there is a slim chance that the requested read amount is a perfect division of block size without any remainder. I will be handling the remaining request in the third case.

The third case occurs if the caller's byte request is not completely fulfilled. To determine if this case is needed, I can check if the count is larger than zero (I will be decrementing it every time I

read data into the caller's buffer). Since this case handles the remaining caller's request, I need to read an additional block of memory and copy the last bit of required data to the caller's buffer. I will then store the excess data in my buffer for future `b_read` calls.

Note: I will check for the end of the file by calculating whether the bytes read from the file exceed the file size and imposing a limit on the caller's request if so. Also, if the count request is less than or equal to zero, I will return the count amount.

For the last function, the `b_close`, I will simply free the buffer I created and set the file information (`fi`) field to null, freeing the file control block. I will also set the tracking variables back to zero.

Issues and Resolutions:

My first issue was regarding my initial approach to the read function. I attempted to read the file content one block at a time, which warranted multiple iterations of `LBaread` calls per caller request. However, this approach ignored a few critical cases, such as directly filling the caller's buffer. The primary reason for this issue was that I assumed a while loop was necessary for the read function. Since the `LBaread` returned the blocks rather than the bytes read, I thought there would be too many if-then cases to consider without the loop.

Image of my issue:

```
while (bytesCopied < count) {
    //Check if buffer needs refilling
    if (fcb->bufferPos >= B_CHUNK_SIZE || fcb->filePos == 0) {
        int blockNum = fcb->filePos / B_CHUNK_SIZE;
        LBaread(fcb->buffer, 1, fcb->fi->location + blockNum);
        fcb->bufferPos = 0;
    }

    //Calculate bytes available in the buffer and bytes to copy
    int bytesAvailable = B_CHUNK_SIZE - fcb->bufferPos;
    int bytesToCopy = (count - bytesCopied < bytesAvailable) ? count - bytesCopied : bytesAvailable;

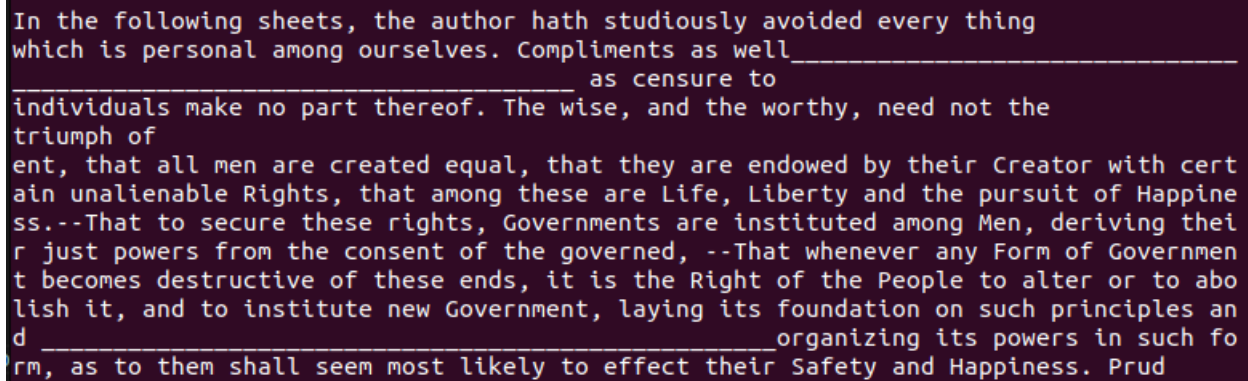
    //Copy data from the buffer to the user buffer
    memcpy(buffer + bytesCopied, fcb->buffer + fcb->bufferPos, bytesToCopy);

    //Update positions and counters
    fcb->bufferPos += bytesToCopy;
    fcb->filePos += bytesToCopy;
    bytesCopied += bytesToCopy;
}

return bytesCopied;
```


I resolved this by completely eradicating my while loop approach and building on the fresh logic where I directly fill the caller's buffer. The approach diagram shows the result of this resolution, where I've considered all the cases in the instructions. The seemingly more difficult task was the more straightforward and efficient approach to the problem than the original loop logic.

My other issue was regarding the output of inconsistent data (shown in the image):



Initially, I assumed my error resulted from incorrect value updates for the buffer position, bytes read, and block offset for the file location. However, carefully tracing the logic did not reveal any noticeable errors or mistakes in updating these variables' increment/decrement logic.

My mistake was in the second case, where I overlooked copying the existing data from my buffer to the caller's buffer before proceeding to read into the caller's buffer directly. Although this sounds complicated, I overlooked the first case that executes before the second one. I was able to resolve this issue by incorporating an offset of bytes copied, as illustrated in the image below:



```
//Handle large read directly to user's buffer
if (count >= B_CHUNK_SIZE) {
    //Read large chunk of blocks at once directly to USER's buffer
    int blocksToRead = count / B_CHUNK_SIZE;

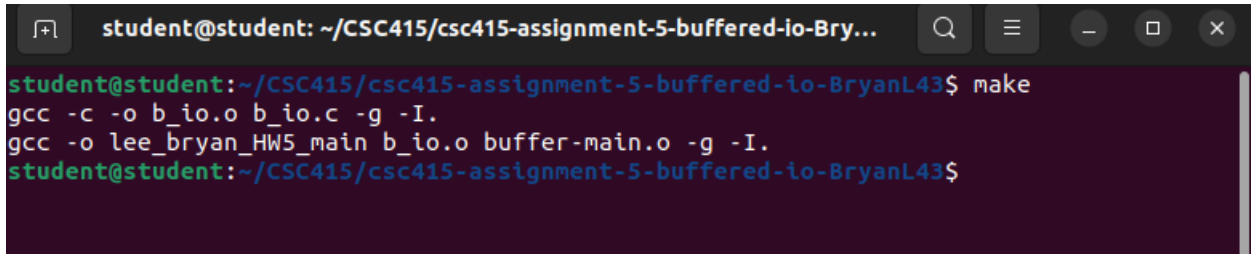
    fcb->blockOffset += LBRead(buffer + bytesCopied, blocksToRead, fcb->fi->location + fcb->blockOffset);

    //Update values
    int bytesRead = blocksToRead * B_CHUNK_SIZE;
    bytesCopied += bytesRead;
    count -= bytesRead;
}
```

The offset ensures new contents are correctly positioned in the buffer and ready to receive incoming data.

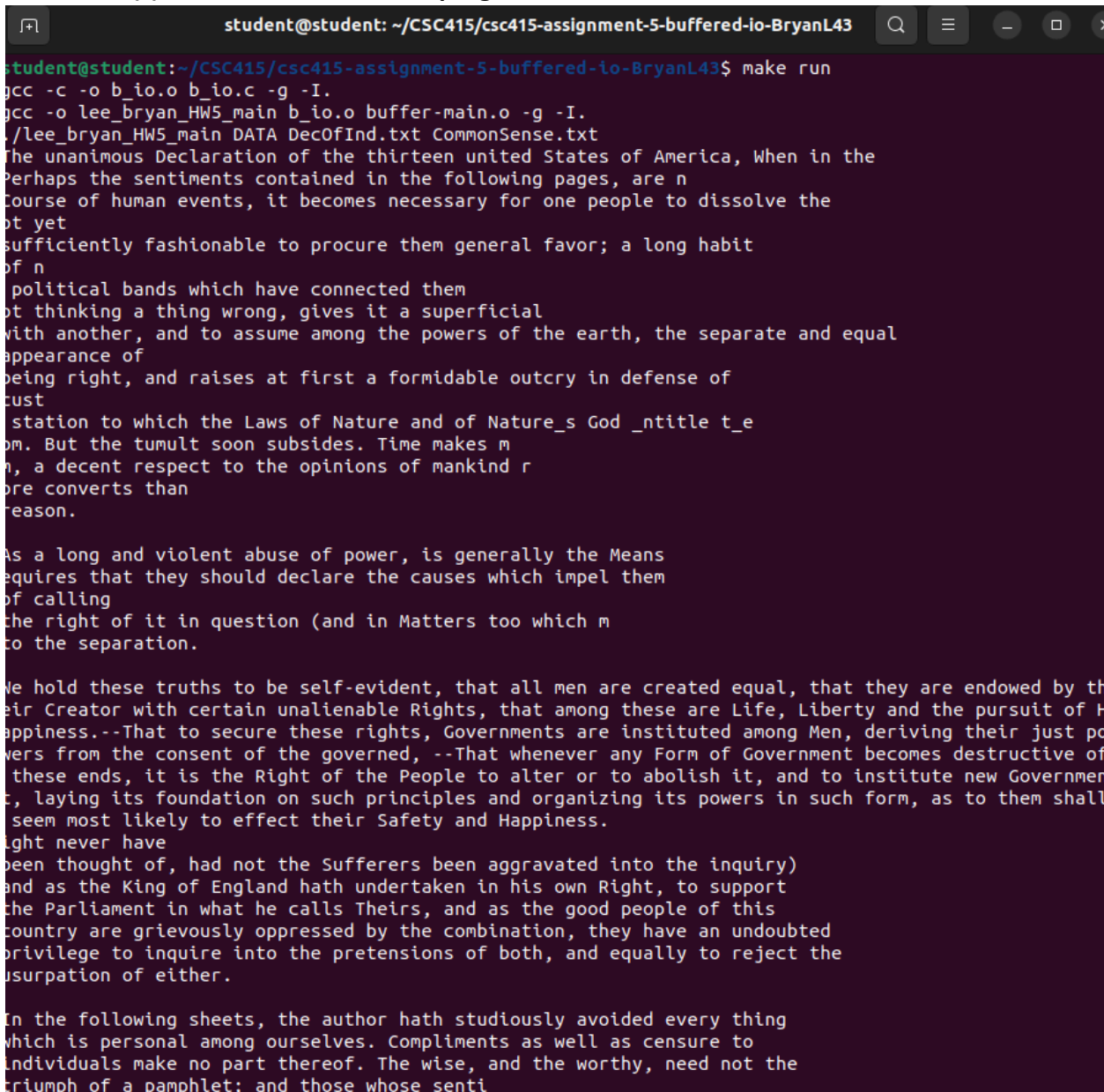
Analysis: N/A

Screenshot of compilation:



```
student@student: ~/CSC415/csc415-assignment-5-buffered-io-Bry...
student@student:~/CSC415/csc415-assignment-5-buffered-io-BryanL43$ make
gcc -c -o b_io.o b_io.c -g -I.
gcc -o lee_bryan_HW5_main b_io.o buffer-main.o -g -I.
student@student:~/CSC415/csc415-assignment-5-buffered-io-BryanL43$
```

Screenshot(s) of the execution of the program:



```
student@student:~/CSC415/csc415-assignment-5-buffered-io-BryanL43$ make run
gcc -c -o b_io.o b_io.c -g -I.
gcc -o lee_bryan_HW5_main b_io.o buffer-main.o -g -I.
./lee_bryan_HW5_main DATA DecOfInd.txt CommonSense.txt
The unanimous Declaration of the thirteen united States of America, When in the
Perhaps the sentiments contained in the following pages, are n
course of human events, it becomes necessary for one people to dissolve the
ot yet
sufficiently fashionable to procure them general favor; a long habit
of n
political bands which have connected them
ot thinking a thing wrong, gives it a superficial
with another, and to assume among the powers of the earth, the separate and equal
appearance of
being right, and raises at first a formidable outcry in defense of
tust
station to which the Laws of Nature and of Nature's God _ntitle t_e
om. But the tumult soon subsides. Time makes m
n, a decent respect to the opinions of mankind r
ore converts than
reason.

As a long and violent abuse of power, is generally the Means
requires that they should declare the causes which impel them
of calling
the right of it in question (and in Matters too which m
to the separation.

We hold these truths to be self-evident, that all men are created equal, that they are endowed by th
eir Creator with certain unalienable Rights, that among these are Life, Liberty and the pursuit of H
appiness.--That to secure these rights, Governments are instituted among Men, deriving their just po
vers from the consent of the governed, --That whenever any Form of Government becomes destructive of
these ends, it is the 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.
ight never have
been thought of, had not the Sufferers been aggravated into the inquiry)
and as the King of England hath undertaken in his own Right, to support
the Parliament in what he calls Theirs, and as the good people of this
country are grievously oppressed by the combination, they have an undoubted
privilege to inquire into the pretensions of both, and equally to reject the
usurpation of either.

In the following sheets, the author hath studiously avoided every thing
which is personal among ourselves. Compliments as well as censure to
individuals make no part thereof. The wise, and the worthy, need not the
triumph of a pamphlet; and those whose senti
```

```
student@student: ~/CSC415/csc415-assignment-5-buffered-io-BryanL43
erump of a purpree; and those whose sense
Prudence, indeed, will dictate that Governments long established should not be cha
ments are injudicious, or
unfriendly, will cease of t
nged for light and transient causes; and accordingly all experienc
hemselves unless too much pains are bestowed
e hath shewn, that mankind are more disposed to suffe
upon their conversion.

The cause of America is in a great meas
r, while evils are sufferable, than to right themselves by abolishing
ure the cause of all mankind. Many
circumstances hath, and will arise, which are no
the forms to which they are accustomed. But when a long trai
t local, but universal, and
through whi
n of abuses and usurpations, pursuing invariably the same Obje
ch the principles of all Lovers of Mankind are affected, and in
the Event of wh
ct evinces a design to reduce them under ab
ich, their Affections are interested. The laying a Country
desolate with Fire and
solute Despotism, it is their right, it is their duty, to throw off such Govern
Sword, declaring War against the natural rights of all
Ma
ment, and to provide new Guards for their future securi
nkind, and extirpating the Defenders thereof from the Face of the Earth,
is the Concern
ty.--Such has been the patient sufferance of thes
of every Man to whom Nature hath given the Power of feeling;
of which Class, rega
e Colonies; and such is now the necessity which constrains them to alter
rdless of Party Censure, is the

AUTHOR
their former Systems of Government. The history of the present King of Great B
ritain is a history of repeated injuries and usurpations, all having i
n direct object the establishment of an absolute Tyranny over these State
s. To prove this, let Facts be submitted to a candid world.

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

He has forbidden his Governors to pass Laws of immediate and
pressing importance, unless suspended in their operation ti
```

```
student@student: ~/CSC415/csc415-assignment-5-buffered-io-BryanL43

ll his Assent should be obtained; and when so suspended, he has utterly neglected to at
tend to them.

He has refused to pass other Laws for the accommodat
ion of large districts of people, unless those people would rel
inquish the right of Representation in the Legislature, a right inesti
mable to them and formidable to tyrants only.

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

He has dissolved Representative Houses repeatedly, for o
pposing 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; whereby the Legislative pow
ers, 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 in
vasion from without, and convulsions within.

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

He has obstruct
ed the Administration of Justice, by refusing his Assent to Law
s for establishing Judiciary powers.

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

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

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

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

```
student@student: ~/CSC415/csc415-assignment-5-buffered-io-BryanL43

He has co
mbined with others to subject us to a jurisdiction forei
gn to our constitution, and unacknowledged by our laws;
giving his Assent to their Acts of pretended Legislation:

For Q
uartering large bodies of armed troops a
mong us:

For protecting them, by a mock Trial, from punishment f
or any Murders which they should commit on the Inhabitants of these States:

For cutti
ng off our Trade with all parts of the world:

For imposing Ta
xes on us without our Consent:

For depriving us in many case
s, of the benefits of Trial by Jury:

For transporting us beyon
d Seas to be tried for pretended offences

For
abolishing the free System of English Laws in a nei
ghbouring Province, establishing therein an A
rbitrary government, and enlarging its Boundaries so as t
o render it at once an example and fit instrument for introducing th
e same absolute rule into these Colonies:

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

For suspending our own Legislatures, and decl
aring themselves invested with power to legislate for us in all cases wh
atsoever.

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

He has pl
undered our seas, ravaged our Coasts, burnt our towns, a
nd destroyed the lives of our people.
```



```
student@student: ~/CSC415/csc415-assignment-5-buffered-io-BryanL43
no destroyed the lives of our people.

He is at this t
ime transporting large Armies of foreign Mercenaries to compleat the works of death,
desolation and tyranny, already begun with circumstances of Cruelty & perfidy scarc
ely paralleled in the most barbarous ages, and totally unw
orthy the Head of a civilized nation.

He has constrained our fell
ow 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 thems
elves by their Hands.

He has excited domestic insur
rections amongst us, and has endeavoured to bring on the in
habitants of our frontiers, the merciless Indian Savages, wh
ose known rule of warfare, is an undistinguished de
struction of all ages, sexes and conditions.

In every stage of these Oppressions We h
ave Petitioned for Redress in the most humble terms: Our repeated Pet
itions have been answered only by repeated injury. A Prince whose character is thus mark
ed by every act which may define a Tyrant, is unfit to
be the ruler of a free people.

Nor have We
been wanting in attentions to our Brittish brethren. We have warne
d them from time to time of attempts by their legislatu
re to extend an unwarrantable jurisdiction over us. We have rem
inded them of the circumstances of our emigration and settlemen
t here. We have appealed to their native justice and magnanimity, and we
have conjured them by the ties of our common kindred to disavow these usurpations
, which, would inevitably interrupt our connections and corres
pondence. They too have been deaf to the voice
of justice and of consanguinity. We must, therefore, acquiesce in the necessity, wh
ich denounces our Separation, and hold them, as we hold the rest of mankind, Enemies in
War, in Peace Friends.

We, therefore, the Representatives of the
united States of America, in General Congress, Assembled, app
ealing to the Supreme Judge of the world for the rectitude of our intentions, do, in the N
ame, and by Authority of the good People of the
se Colonies, solemnly publish and declare, That
these United Colonies are, and of Right ought to be Free and Independent States; th
at they are Absolved from all Allegiance to the B
ritish Crown, and that all political conn
ection between them and the State of Great Britain, is

ection between them and the State of Great Britain, is
and ought to be totally dissolved; and that
as Free and Independent States, they have full Power to levy
War, conclude Peace, contract Alliances
, establish Commerce, and to do all other Acts and Things which Independent States may o
f right do. And for the support of this Declaration, with a firm relia
nce on the protection of divine Providence, we mutually pledge to each ot
her our Lives, our Fortunes and our sacred Honor.
We have read 8120 characters from file DecOfInd.txt
We have read 1877 characters from file CommonSense.txt
student@student:~/CSC415/csc415-assignment-5-buffered-io-BryanL43$
```