ELEE-1147 Programming for Engineers

“The second Most Intelligent Species….”

July 15, 2022

Aakash Dutt Mathur

001093856

Aim: To extract information from the given audio files.

Introduction: We are provided with 2 audio files at different baud rates. These files contain the same message. The amount of data would be huge i.e. 122,880 samples per file. It would be very difficult for the audio engineer to deal with a single reading and manipulate it 20000 times instead dividing the data in blocks is a better option for handling such a huge amount of audio signals.

Task 1a:

Algorithm:

Step 1: The first step involves reading the signal. As there are binary files provided, the input data will be read from them instead of the STDIN. For this the binfileread function is made.
Step 2: The second step would be manipulating the data we got from reading that file. This step involves sorting the signal data, conversion to dits and dahs, ON/OFF, etc. This is done using the decimate function called in the main().
Step 3: Lastly using the binfilewrite, the discrete data can be rewritten and presented as an output to the viewer. Data would be returned in the form of an array.

Flow of information in the system:

Data In	**Process**	**Data Out**
Step 1: STDIN(Keyboard) (Not used)		**Step 1:** STDOUT(Terminal/VDU)
Step 2: Retrieve ground truth data from disk (Binary file in our case)		Step 2: Send verified data to disk
Step 3: Real data via communications channel		Step 3: Real-time data

Role of sub processes or functions called by main():

Process

Sub Process 1	Sub Process 2	Sub Process 3
binfileread.o	decimate.o	binfilewrite.o
binfileread() function contains: binfileread.cpp binfileread.hpp	decimate() function contains: decimate.cpp decimate.hpp	binfilewrite() function contains: binfilewrite.cpp binfilewrite.hpp

Both .cpp (source files) and .hpp (header) files are compiled to produce .o (object) files.
These object files are further linked to produce .exe or the executable file for the program to run.

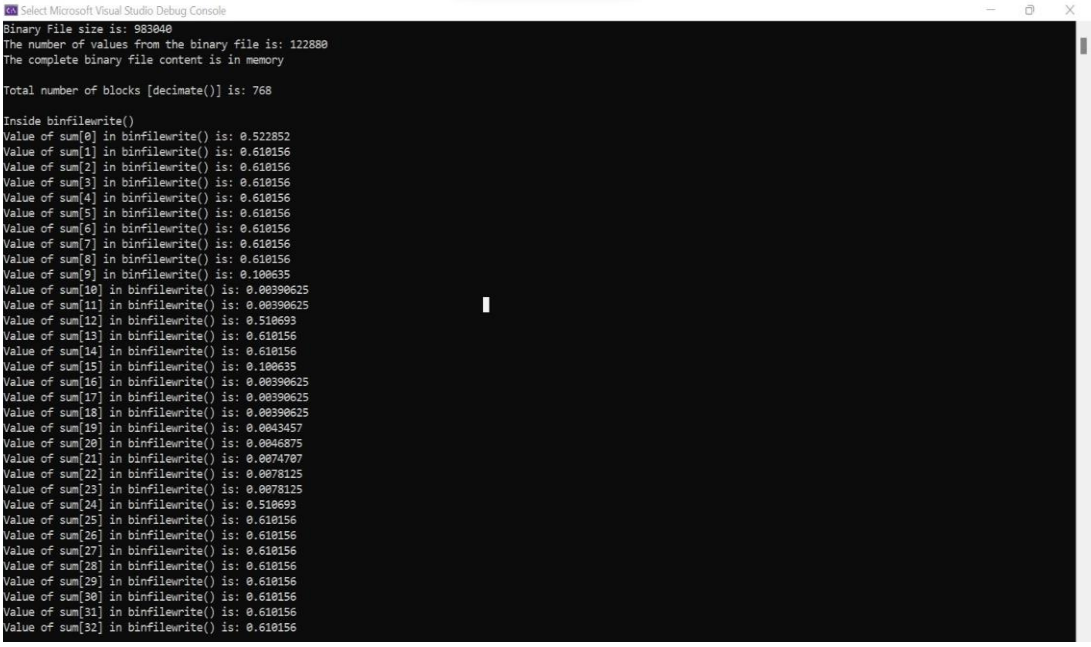
(.cpp & .hpp) -------------linker--------------→(.o) ------------Compiler---------→.exe (executable file)

Task 1b:

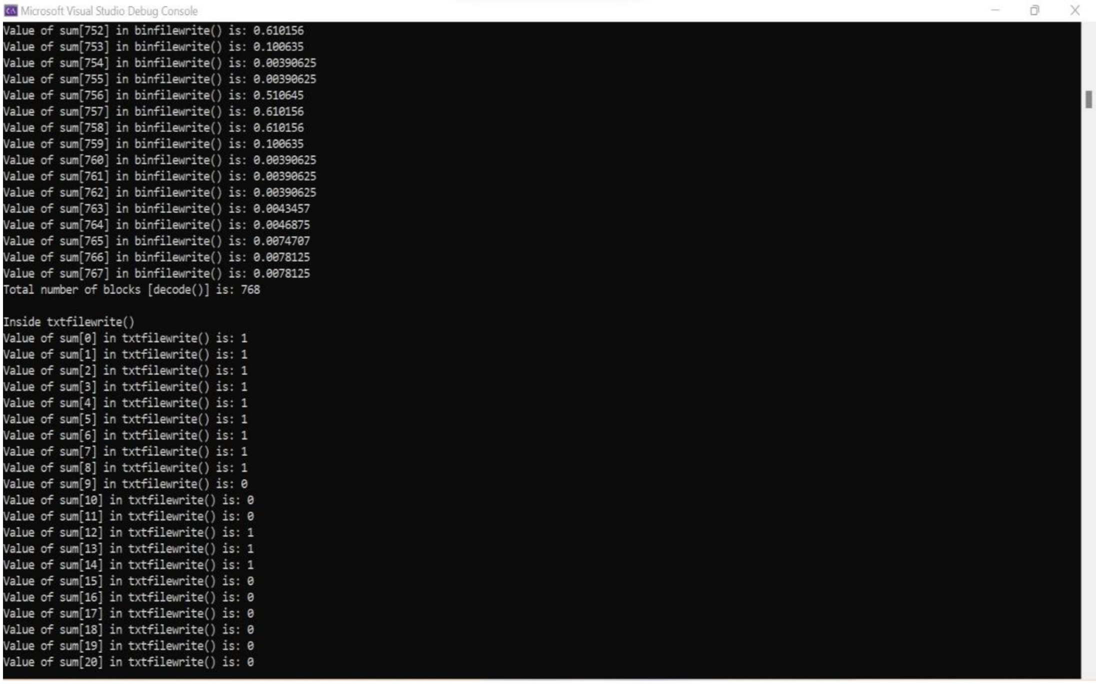
IDE Used: Visual studio 2022

The .cpp files or the source files are placed in the source folder in an empty project, and the header files are placed in the header folder.

The project is then built and run, and the output is:



```
Binary File size is: 983040
The number of values from the binary file is: 122880
The complete binary file content is in memory

Total number of blocks [decimate()] is: 768

Inside binfilewrite()
Value of sum[0] in binfilewrite() is: 0.522852
Value of sum[1] in binfilewrite() is: 0.610156
Value of sum[2] in binfilewrite() is: 0.610156
Value of sum[3] in binfilewrite() is: 0.610156
Value of sum[4] in binfilewrite() is: 0.610156
Value of sum[5] in binfilewrite() is: 0.610156
Value of sum[6] in binfilewrite() is: 0.610156
Value of sum[7] in binfilewrite() is: 0.610156
Value of sum[8] in binfilewrite() is: 0.610156
Value of sum[9] in binfilewrite() is: 0.100635
Value of sum[10] in binfilewrite() is: 0.00390625
Value of sum[11] in binfilewrite() is: 0.00390625
Value of sum[12] in binfilewrite() is: 0.510693
Value of sum[13] in binfilewrite() is: 0.610156
Value of sum[14] in binfilewrite() is: 0.610156
Value of sum[15] in binfilewrite() is: 0.100635
Value of sum[16] in binfilewrite() is: 0.00390625
Value of sum[17] in binfilewrite() is: 0.00390625
Value of sum[18] in binfilewrite() is: 0.00390625
Value of sum[19] in binfilewrite() is: 0.0043457
Value of sum[20] in binfilewrite() is: 0.0046875
Value of sum[21] in binfilewrite() is: 0.0074707
Value of sum[22] in binfilewrite() is: 0.0078125
Value of sum[23] in binfilewrite() is: 0.0078125
Value of sum[24] in binfilewrite() is: 0.510693
Value of sum[25] in binfilewrite() is: 0.610156
Value of sum[26] in binfilewrite() is: 0.610156
Value of sum[27] in binfilewrite() is: 0.610156
Value of sum[28] in binfilewrite() is: 0.610156
Value of sum[29] in binfilewrite() is: 0.610156
Value of sum[30] in binfilewrite() is: 0.610156
Value of sum[31] in binfilewrite() is: 0.610156
Value of sum[32] in binfilewrite() is: 0.610156
```



```
Value of sum[752] in binfilewrite() is: 0.610156
Value of sum[753] in binfilewrite() is: 0.100635
Value of sum[754] in binfilewrite() is: 0.00390625
Value of sum[755] in binfilewrite() is: 0.00390625
Value of sum[756] in binfilewrite() is: 0.510645
Value of sum[757] in binfilewrite() is: 0.610156
Value of sum[758] in binfilewrite() is: 0.610156
Value of sum[759] in binfilewrite() is: 0.100635
Value of sum[760] in binfilewrite() is: 0.00390625
Value of sum[761] in binfilewrite() is: 0.00390625
Value of sum[762] in binfilewrite() is: 0.00390625
Value of sum[763] in binfilewrite() is: 0.0043457
Value of sum[764] in binfilewrite() is: 0.0046875
Value of sum[765] in binfilewrite() is: 0.0074707
Value of sum[766] in binfilewrite() is: 0.0078125
Value of sum[767] in binfilewrite() is: 0.0078125
Total number of blocks [decode()] is: 768

Inside txtfilewrite()
Value of sum[0] in txtfilewrite() is: 1
Value of sum[1] in txtfilewrite() is: 1
Value of sum[2] in txtfilewrite() is: 1
Value of sum[3] in txtfilewrite() is: 1
Value of sum[4] in txtfilewrite() is: 1
Value of sum[5] in txtfilewrite() is: 1
Value of sum[6] in txtfilewrite() is: 1
Value of sum[7] in txtfilewrite() is: 1
Value of sum[8] in txtfilewrite() is: 1
Value of sum[9] in txtfilewrite() is: 0
Value of sum[10] in txtfilewrite() is: 0
Value of sum[11] in txtfilewrite() is: 0
Value of sum[12] in txtfilewrite() is: 1
Value of sum[13] in txtfilewrite() is: 1
Value of sum[14] in txtfilewrite() is: 1
Value of sum[15] in txtfilewrite() is: 0
Value of sum[16] in txtfilewrite() is: 0
Value of sum[17] in txtfilewrite() is: 0
Value of sum[18] in txtfilewrite() is: 0
Value of sum[19] in txtfilewrite() is: 0
Value of sum[20] in txtfilewrite() is: 0
```

Observation: Here we notice that the binfilewrite gives the true value of the output signal sample but as we move to the textfilewrite we obtain the exact binary values in the form of 0s and 1s which is perfect for our use.

Task 2:

The focus of this task is to make the data more manageable by maintaining the integrity and not losing any information. For this purpose, some diagrams can be used to analyse the data in the files.

For this purpose, we use MATLAB to plot the various graphs for both the audio files and try to spot the dits and dahs.

Visualising the data:

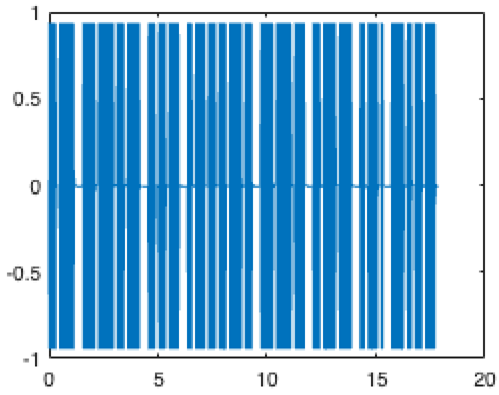
Here the plotting of the binary files is done using MATLAB. This is done by keeping the frequency of the message (fs) 8kHz, opening the file and plotting the message inside it in the timeframe of 2.5 seconds.

For dolphins_20wpm.bin :

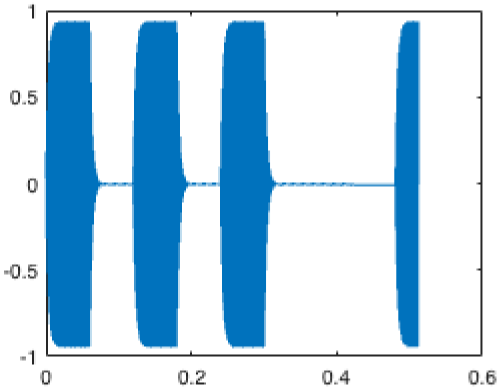
MATLAB Code and Output:

```
fid = fopen('dolphins_20wpm.bin');
data = fread(fid, 'double');
fclose(fid);
figure(1), plot(data)
```

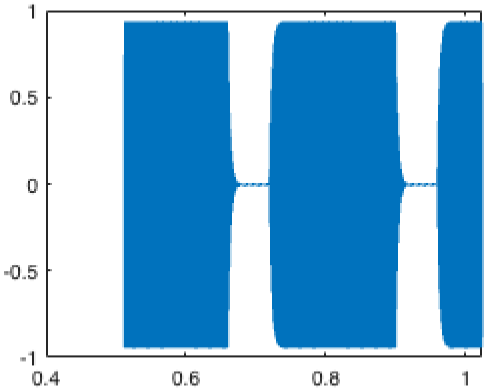
```
fs = 8000;
t = (0:(1/fs):(length(data)/fs)-(1/fs));
t = t';
figure(1), plot(data)
plot(t, data)
```



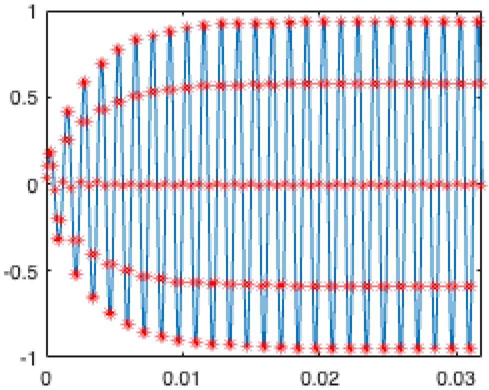
```
plot(t(1:4096),data(1:4096))
```



```
figure(2), plot(t(4097:8192), data(4097:8192));
```

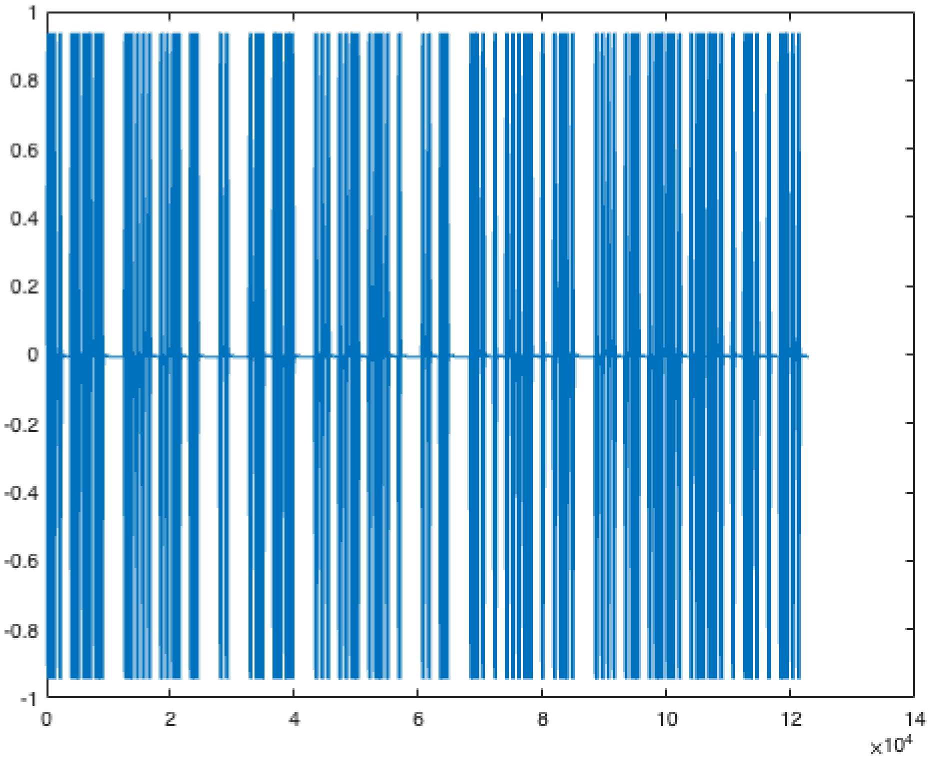


```
figure(3), plot(t(1:256), data(1:256)), hold on, plot(t(1:256), data(1:256), 'r*')
```

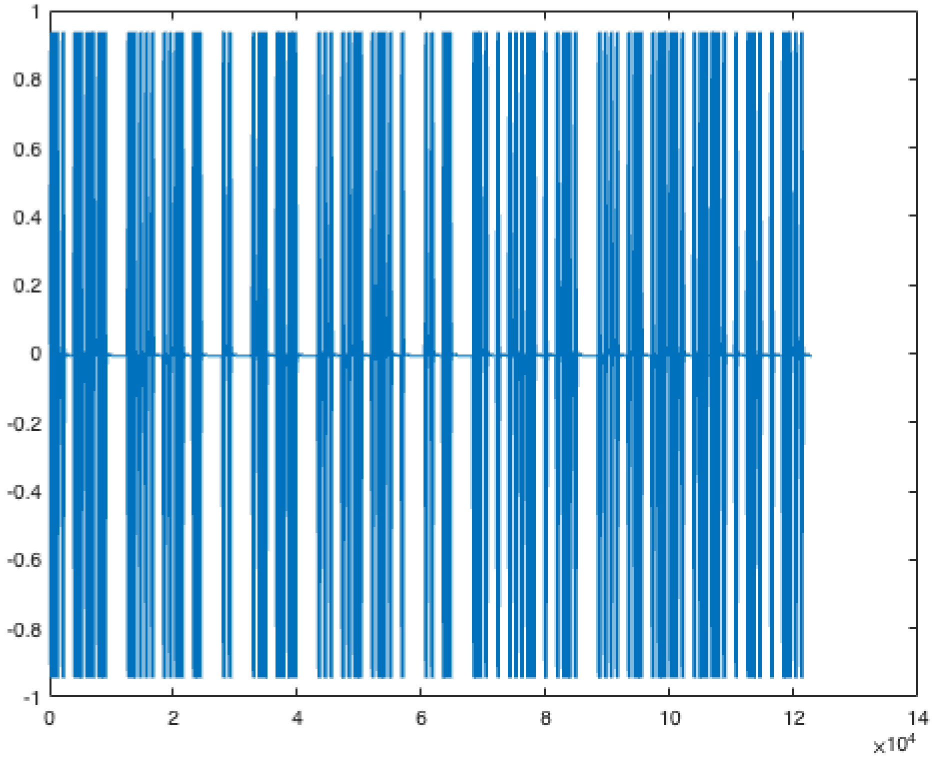


For boris_Nov13_20wpm.bin :

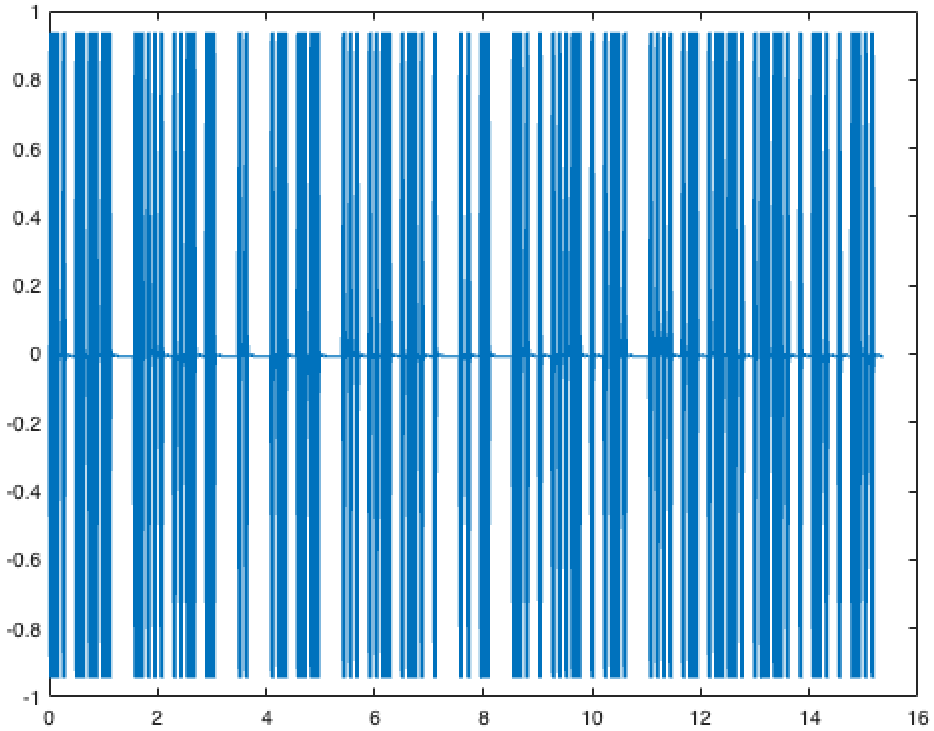
```
fid = fopen('boris_Nov13_20wpm.bin');
data = fread(fid, 'double');
fclose(fid);
figure(1), plot(data)
```



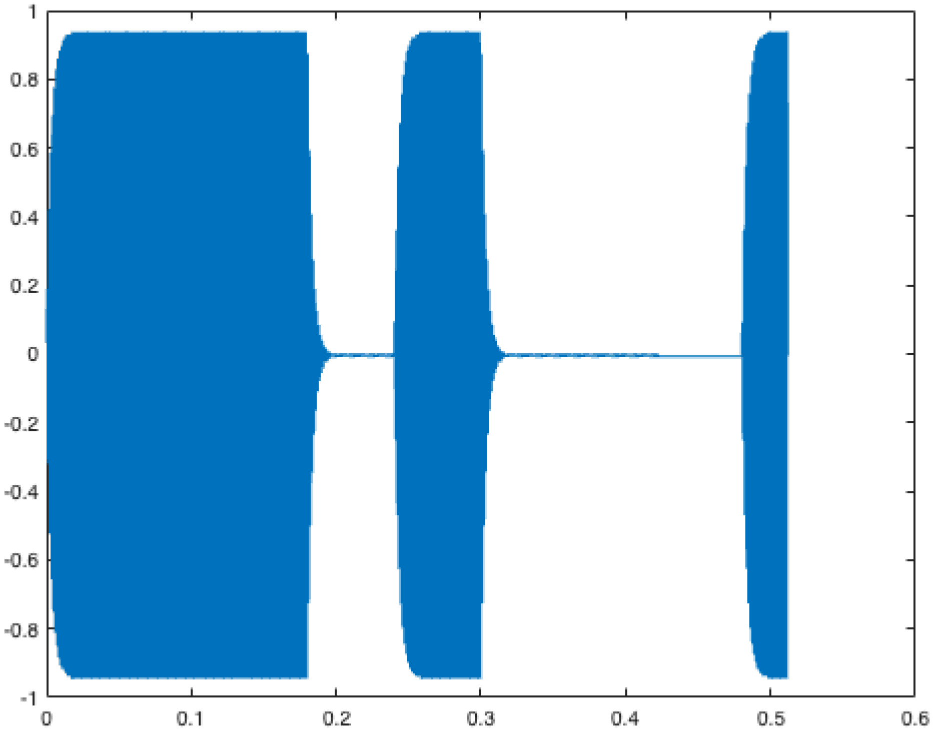
```
fs = 8000;
t = (0:(1/fs):(length(data)/fs)-(1/fs));
t = t';
figure(1), plot(data)
```


1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0
2
4
6
8
10
12
14
×10^4

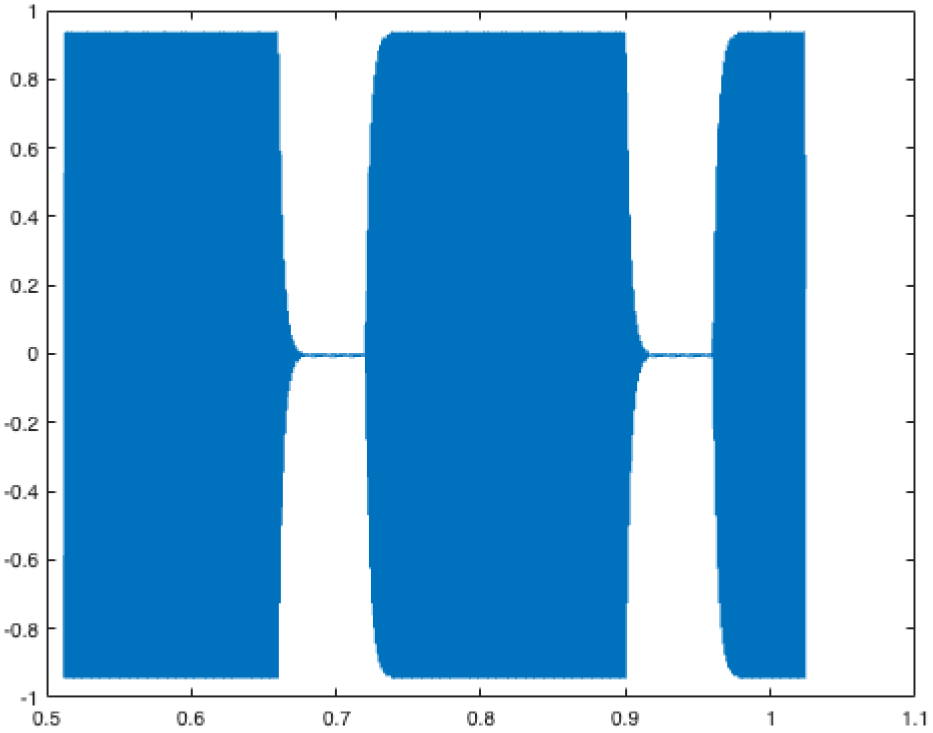
```
plot(t, data)
```


1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0
2
4
6
8
10
12
14
16

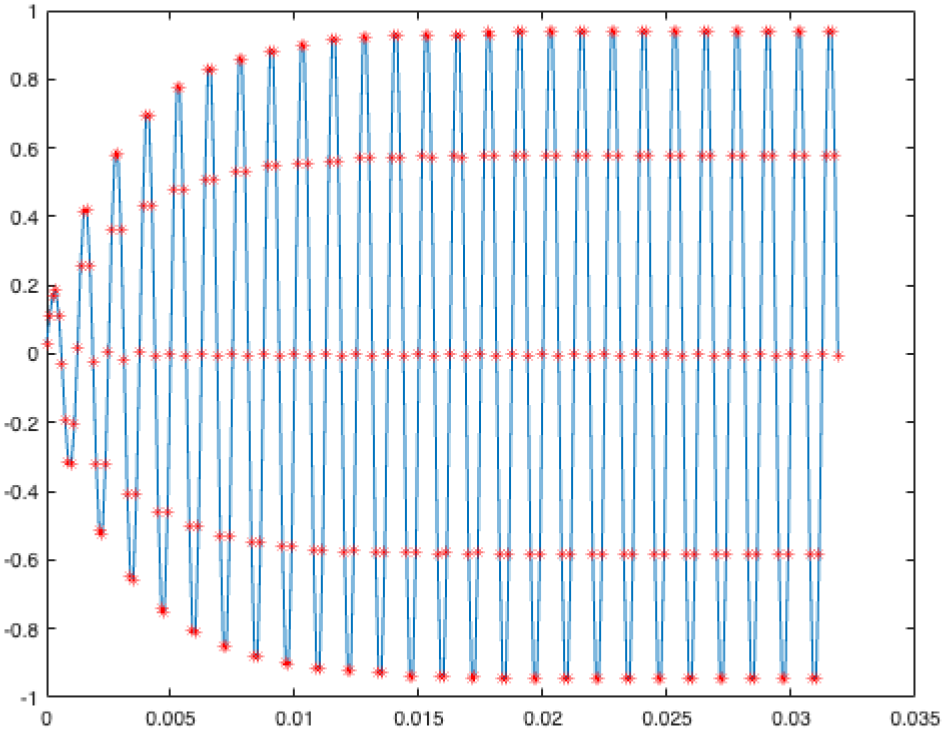
```
plot(t(1:4096),data(1:4096))
```



```
figure(2), plot(t(4097:8192), data(4097:8192));
```

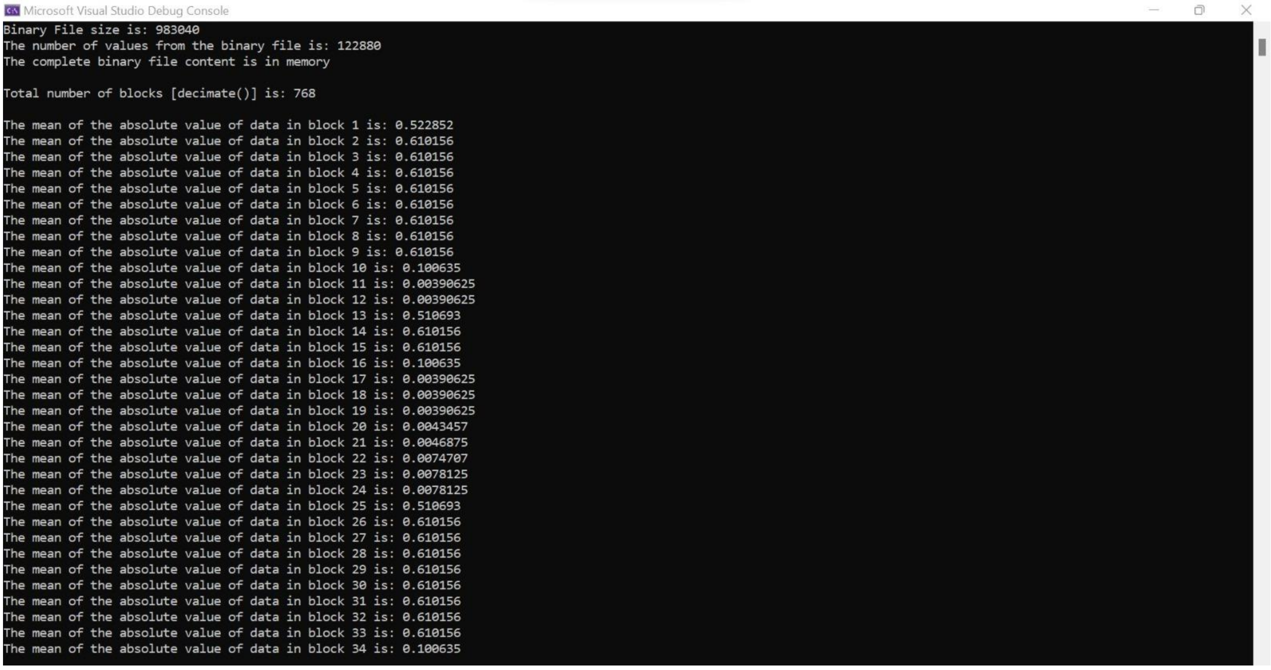


```
figure(3), plot(t(1:256), data(1:256)), hold on, plot(t(1:256), data(1:256), 'r*')
```



Manipulation & Sorting:

Here, the data manipulation is done according to the value of each sample as shown in the output.



```
Binary File size is: 983040
The number of values from the binary file is: 122880
The complete binary file content is in memory

Total number of blocks [decimate()] is: 768

The mean of the absolute value of data in block 1 is: 0.522852
The mean of the absolute value of data in block 2 is: 0.610156
The mean of the absolute value of data in block 3 is: 0.610156
The mean of the absolute value of data in block 4 is: 0.610156
The mean of the absolute value of data in block 5 is: 0.610156
The mean of the absolute value of data in block 6 is: 0.610156
The mean of the absolute value of data in block 7 is: 0.610156
The mean of the absolute value of data in block 8 is: 0.610156
The mean of the absolute value of data in block 9 is: 0.610156
The mean of the absolute value of data in block 10 is: 0.100635
The mean of the absolute value of data in block 11 is: 0.00390625
The mean of the absolute value of data in block 12 is: 0.00390625
The mean of the absolute value of data in block 13 is: 0.510693
The mean of the absolute value of data in block 14 is: 0.610156
The mean of the absolute value of data in block 15 is: 0.610156
The mean of the absolute value of data in block 16 is: 0.100635
The mean of the absolute value of data in block 17 is: 0.00390625
The mean of the absolute value of data in block 18 is: 0.00390625
The mean of the absolute value of data in block 19 is: 0.00390625
The mean of the absolute value of data in block 20 is: 0.0043457
The mean of the absolute value of data in block 21 is: 0.0046875
The mean of the absolute value of data in block 22 is: 0.0074707
The mean of the absolute value of data in block 23 is: 0.0078125
The mean of the absolute value of data in block 24 is: 0.0078125
The mean of the absolute value of data in block 25 is: 0.510693
The mean of the absolute value of data in block 26 is: 0.610156
The mean of the absolute value of data in block 27 is: 0.610156
The mean of the absolute value of data in block 28 is: 0.610156
The mean of the absolute value of data in block 29 is: 0.610156
The mean of the absolute value of data in block 30 is: 0.610156
The mean of the absolute value of data in block 31 is: 0.610156
The mean of the absolute value of data in block 32 is: 0.610156
The mean of the absolute value of data in block 33 is: 0.610156
The mean of the absolute value of data in block 34 is: 0.100635
```

As it is very difficult to reach out to every sample, this task of sorting is done with the help of if/else statement.

A standard threshold value is set. Each sample will be trimmed, sorted or judged according to this value. We set this value to be “0.5”.

Case A: if the value of the audio sample is less than 0.5, the signal will be considered as “OFF”

Case B: Else if the value of the sample is equal to or greater than 0.5 then the signal will be considered as “ON”

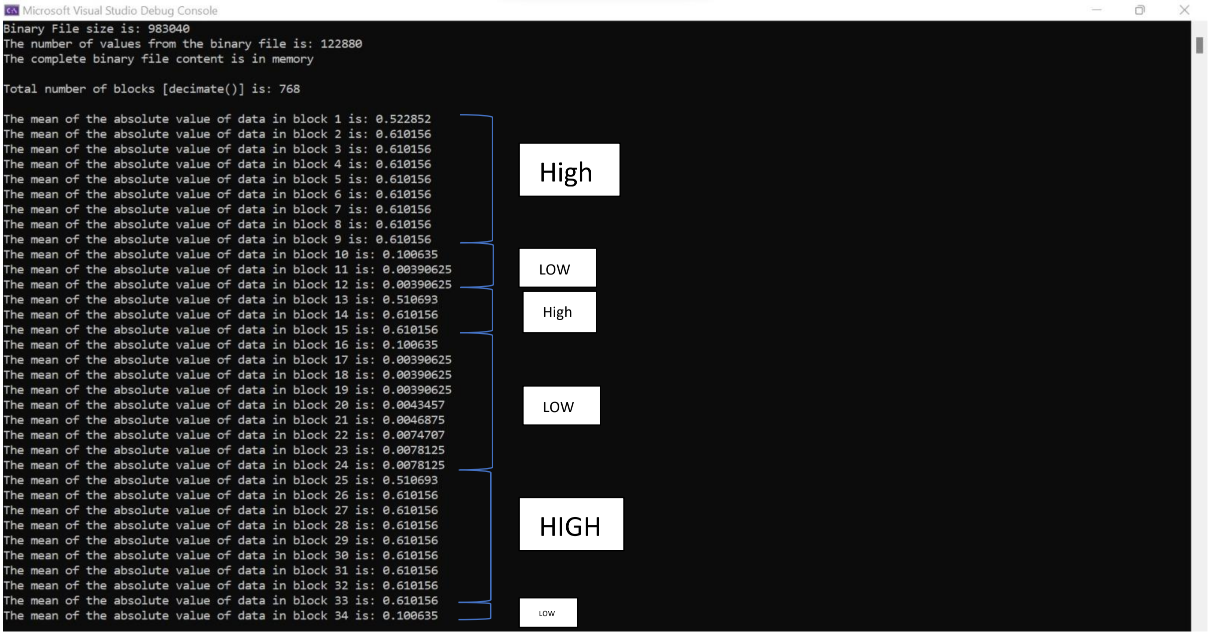
Code for if/else in the getContentFromSignal.cpp:

Void getContentFromSignal::checkONandOFF(vector<double>m, int j){

```
        if (mean[j] > 0.5)

        {

                countON++;

                countOFF = 0;

        }else{

                countOFF++;

                countON = 0;

                }

        }
```

Conclusion from task 2: This will help us to manually sort the data into signal ON or signal OFF.

Manual Interpretation of HIGHs and LOWs:



```
Binary File size is: 983040
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The mean of the absolute value of data in block 3 is: 0.610156
The mean of the absolute value of data in block 4 is: 0.610156
The mean of the absolute value of data in block 5 is: 0.610156
The mean of the absolute value of data in block 6 is: 0.610156
The mean of the absolute value of data in block 7 is: 0.610156
The mean of the absolute value of data in block 8 is: 0.610156
The mean of the absolute value of data in block 9 is: 0.610156
The mean of the absolute value of data in block 10 is: 0.100635
The mean of the absolute value of data in block 11 is: 0.00390625
The mean of the absolute value of data in block 12 is: 0.00390625
The mean of the absolute value of data in block 13 is: 0.510693
The mean of the absolute value of data in block 14 is: 0.610156
The mean of the absolute value of data in block 15 is: 0.610156
The mean of the absolute value of data in block 16 is: 0.100635
The mean of the absolute value of data in block 17 is: 0.00390625
The mean of the absolute value of data in block 18 is: 0.00390625
The mean of the absolute value of data in block 19 is: 0.00390625
The mean of the absolute value of data in block 20 is: 0.0043457
The mean of the absolute value of data in block 21 is: 0.0046875
The mean of the absolute value of data in block 22 is: 0.0074707
The mean of the absolute value of data in block 23 is: 0.0078125
The mean of the absolute value of data in block 24 is: 0.0078125
The mean of the absolute value of data in block 25 is: 0.510693
The mean of the absolute value of data in block 26 is: 0.610156
The mean of the absolute value of data in block 27 is: 0.610156
The mean of the absolute value of data in block 28 is: 0.610156
The mean of the absolute value of data in block 29 is: 0.610156
The mean of the absolute value of data in block 30 is: 0.610156
The mean of the absolute value of data in block 31 is: 0.610156
The mean of the absolute value of data in block 32 is: 0.610156
The mean of the absolute value of data in block 33 is: 0.610156
The mean of the absolute value of data in block 34 is: 0.100635
```

Task 3:

Now, we must implement the code or the function in task 2.

For this, decimate().cpp must be altered in order to fulfil our needs and manipulate the code according to “Morse norms”.

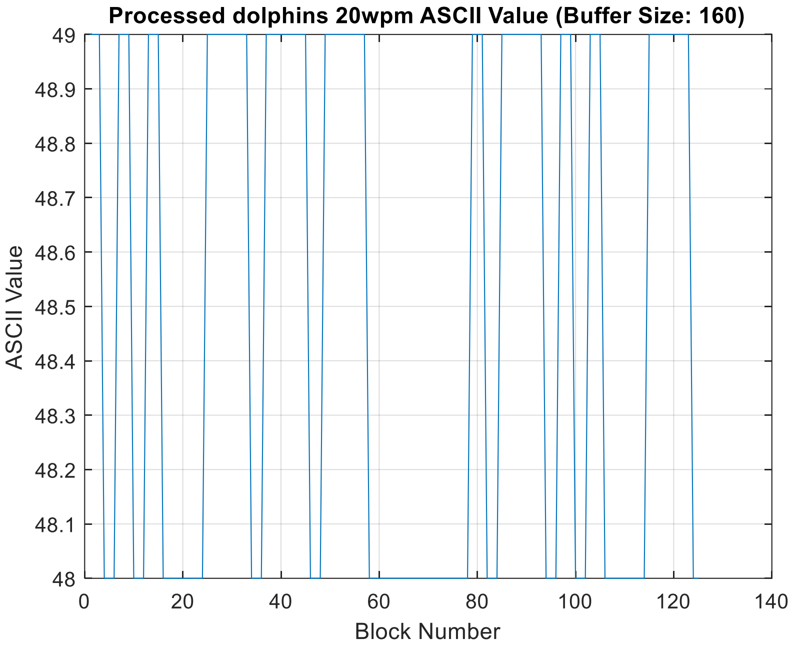
Additional Code for decimate.cpp:

```
//Block of code for calculating the dot and dash values using the baud rate

double calBaudRate = size / BUFFER_SIZE;

   int dotValue = round((calBaudRate / 3) + 1);

   int dashValue = dotValue * 3;

   int IWS = dotValue * 7;


// Lines of code used to check whether the signal is ON or OFF an then take action according to that.

getContent.checkONandOFF(mean, j);

      getContent.takeAction(dashValue, dotValue, IWS);

GetContentFromSignal getContent;
```

```
getContent.displayContent();
```

Morse to English Conversion:

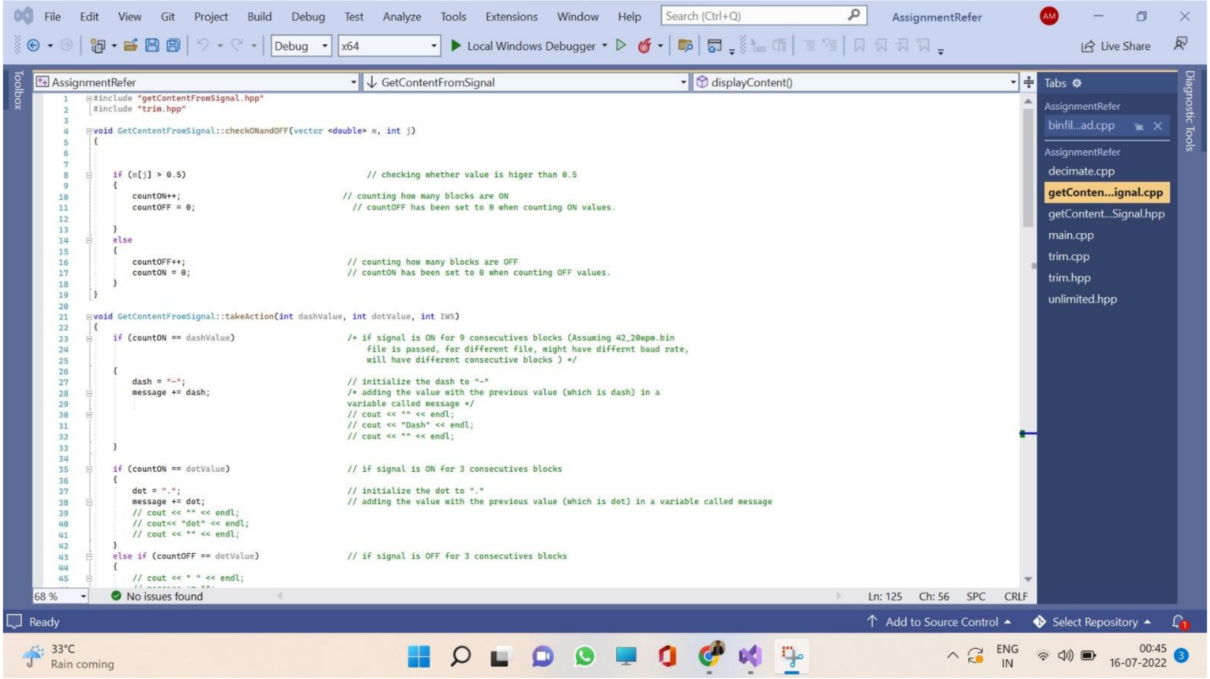
Till now the data has been gathered and categorised it into ONs and OFFs. Now according to the norms of morse code, dits and dahs are formed from the combination of ONs and OFFs.



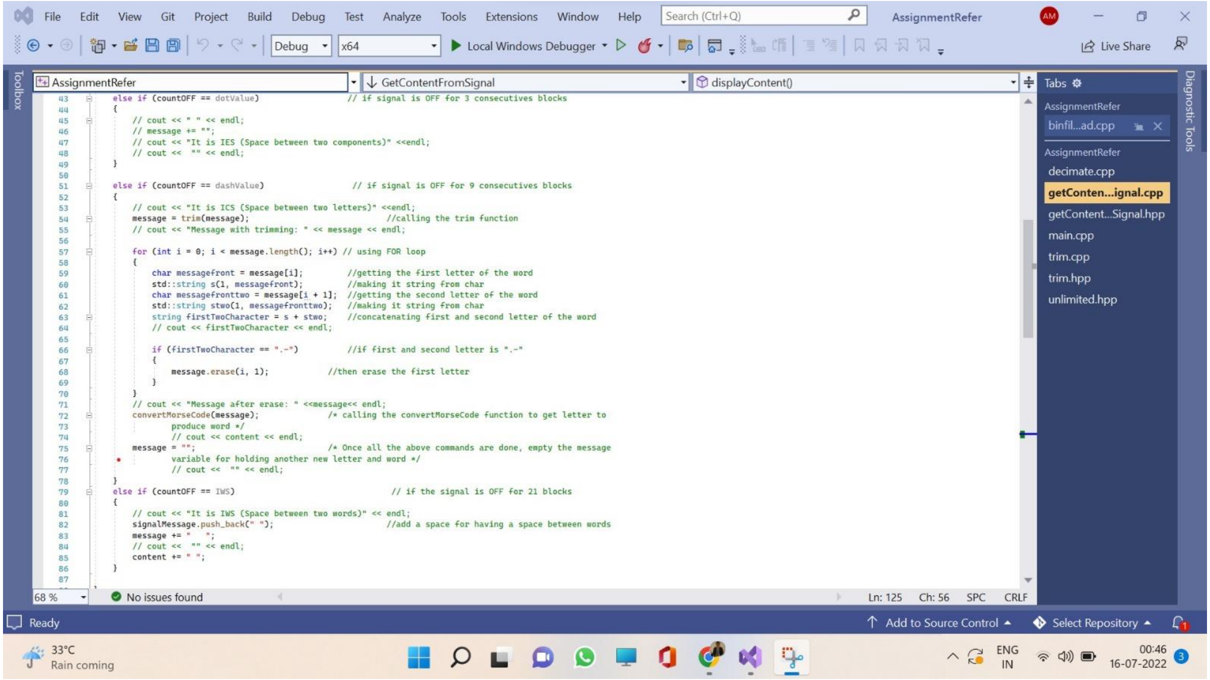
Like in Figure above the buffer size is taken 160 and we see that there are 3 dits in the starting. These are formed by the combination of HIGHs and LOWs.

For this conversion, another file getContentFromSignal.cpp along with getContentFromSignal.hpp is created, this file is included in the main project:

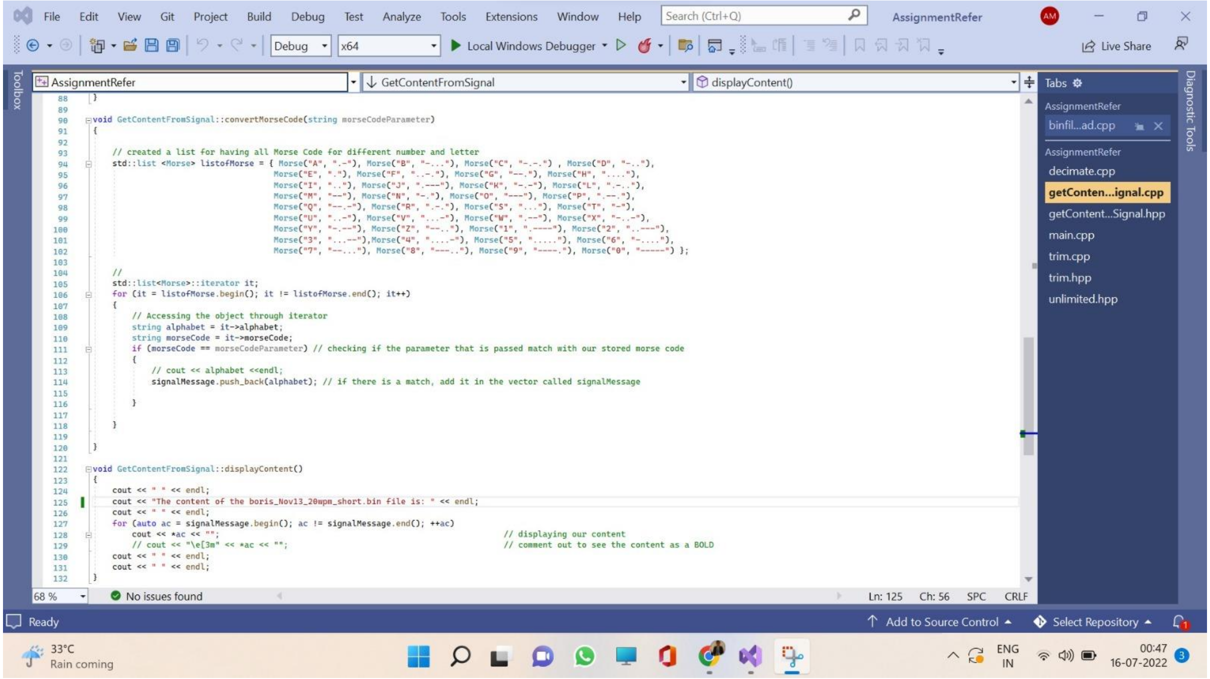
getContentFromSignal.cpp file:



```cpp
#include "getContentFromSignal.hpp"
#include "trim.hpp"

void GetContentFromSignal::checkONandOFF(vector <double> m, int j)
{


    if (m[j] > 0.5)                                     // checking whether value is higer than 0.5
    {
        countON++;                                  // counting how many blocks are ON
        countOFF = 0;                                 // countOFF has been set to 0 when counting ON values.

    }
    else
    {
        countOFF++;                                  // counting how many blocks are OFF
        countON = 0;                                 // countON has been set to 0 when counting OFF values.
    }
}

void GetContentFromSignal::takeAction(int dashValue, int dotValue, int IWS)
{
    if (countON == dashValue)                        /* if signal is ON for 9 consecutives blocks (Assuming 42_20wpm.bin
                                                         file is passed, for different file, might have differnt baud rate,
                                                         will have different consecutive blocks ) */

    {
        dash = "-";                                  // initialize the dash to "-"
        message += dash;                             /* adding the value with the previous value (which is dash) in a
                                                     variable called message */
                                                     // cout << "" << endl;
                                                     // cout << "Dash" << endl;
                                                     // cout << "" << endl;
    }

    if (countON == dotValue)                         // if signal is ON for 3 consecutives blocks
    {
        dot = ".";                                   // initialize the dot to "."
        message += dot;                              // adding the value with the previous value (which is dot) in a variable called message
        // cout << "" << endl;
        // cout<< "dot" << endl;
        // cout << "" << endl;
    }
    else if (countOFF == dotValue)                   // if signal is OFF for 3 consecutives blocks
    {
        // cout << " " << endl;
```

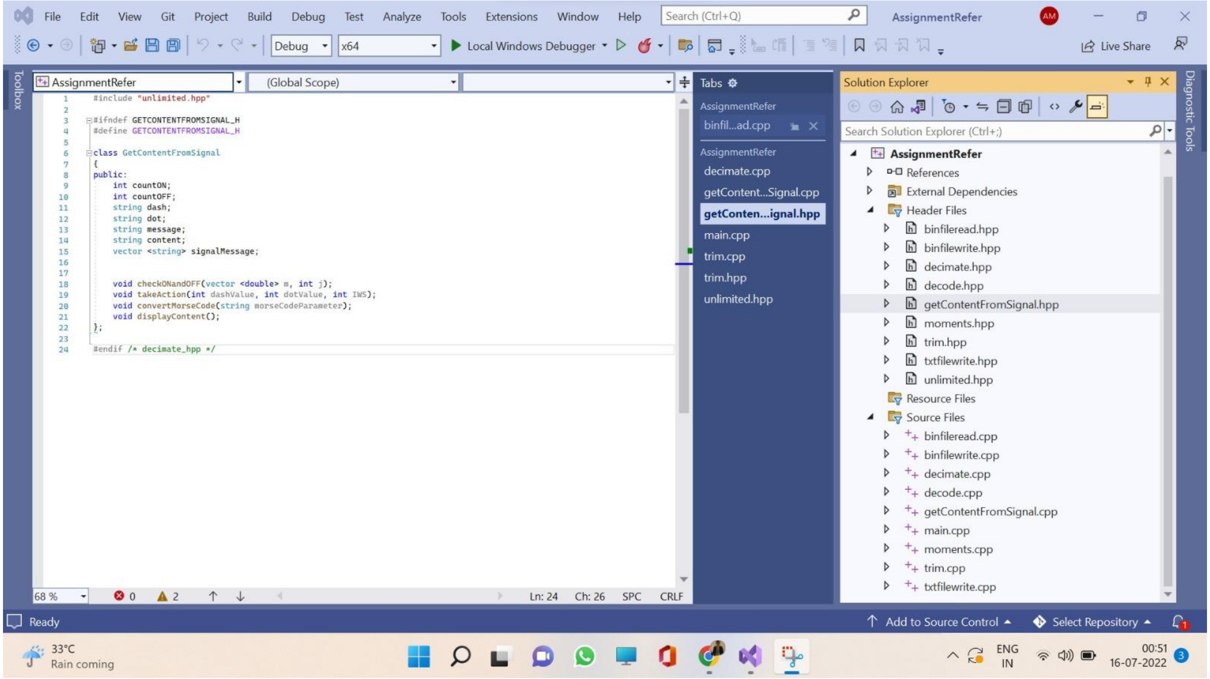


```cpp
    else if (countOFF == dotValue)                   // if signal is OFF for 3 consecutives blocks
    {
        // cout << " " << endl;
        // message += "";
        // cout << "It is IES (Space between two components)" <<endl;
        // cout <<  "" << endl;
    }

    else if (countOFF == dashValue)                   // if signal is OFF for 9 consecutives blocks
    {
        // cout << "It is ICS (Space between two letters)" <<endl;
        message = trim(message);                             //calling the trim function
        // cout << "Message with trimming: " << message << endl;

        for (int i = 0; i < message.length(); i++) // using FOR loop
        {
            char messagefront = message[i];         //getting the first letter of the word
            std::string s(1, messagefront);         //making it string from char
            char messagefronttwo = message[i + 1];  //getting the second letter of the word
            std::string stwo(1, messagefronttwo);   //making it string from char
            string firstTwoCharacter = s + stwo;    //concatenating first and second letter of the word
            // cout << firstTwoCharacter << endl;

            if (firstTwoCharacter == ".-")          //if first and second letter is ".-"
            {
                message.erase(i, 1);            //then erase the first letter
            }
        }
        // cout << "Message after erase: " <<message<< endl;
        convertMorseCode(message);              /* calling the convertMorseCode function to get letter to
                produce word */
                // cout << content << endl;
        message = "";                           /* Once all the above commands are done, empty the message
                variable for holding another new letter and word */
                // cout <<  "" << endl;
    }
    else if (countOFF == IWS)                                 // if the signal is OFF for 21 blocks
    {
        // cout << "It is IWS (Space between two words)" << endl;
        signalMessage.push_back(" ");                         //add a space for having a space between words
        message += "   ";
        // cout <<  "" << endl;
        content += " ";
    }

```



```cpp
}

void GetContentFromSignal::convertMorseCode(string morseCodeParameter)
{

    // created a list for having all Morse Code for different number and letter
    std::list <Morse> listofMorse = { Morse("A", ".-"), Morse("B", "-..."), Morse("C", "-.-.") , Morse("D", "-.."),
                                      Morse("E", "."), Morse("F", "..-."), Morse("G", "--."), Morse("H", "...."),
                                      Morse("I", ".."), Morse("J", ".---"), Morse("K", "-.-"), Morse("L", ".-.."),
                                      Morse("M", "--"), Morse("N", "-."), Morse("O", "---"), Morse("P", ".--."),
                                      Morse("Q", "--.-"), Morse("R", ".-."), Morse("S", "..."), Morse("T", "-"),
                                      Morse("U", "..-"), Morse("V", "...-"), Morse("W", ".--"), Morse("X", "-..-"),
                                      Morse("Y", "-.--"), Morse("Z", "--.."), Morse("1", ".----"), Morse("2", "..---"),
                                      Morse("3", "...--"),Morse("4", "....-"), Morse("5", "....."), Morse("6", "-...."),
                                      Morse("7", "--..."), Morse("8", "---.."), Morse("9", "----."), Morse("0", "-----") };

    //
    std::list<Morse>::iterator it;
    for (it = listofMorse.begin(); it != listofMorse.end(); it++)
    {
        // Accessing the object through iterator
        string alphabet = it->alphabet;
        string morseCode = it->morseCode;
        if (morseCode == morseCodeParameter) // checking if the parameter that is passed match with our stored morse code
        {
            // cout << alphabet <<endl;
            signalMessage.push_back(alphabet); // if there is a match, add it in the vector called signalMessage

        }

    }

}

void GetContentFromSignal::displayContent()
{
    cout << " " << endl;
    cout << "The content of the boris_Nov13_20wpm_short.bin file is: " << endl;
    cout << " " << endl;
    for (auto ac = signalMessage.begin(); ac != signalMessage.end(); ++ac)
        cout << *ac << "";                                              // displaying our content
        // cout << "\e[3m" << *ac << "";                                // comment out to see the content as a BOLD
    cout << " " << endl;
    cout << " " << endl;
}
```

getContentFromSignal.hpp File:



```cpp
#include "unlimited.hpp"

#ifndef GETCONTENTFROMSIGNAL_H
#define GETCONTENTFROMSIGNAL_H

class GetContentFromSignal
{
public:
    int countON;
    int countOFF;
    string dash;
    string dot;
    string message;
    string content;
    vector <string> signalMessage;


    void checkONandOFF(vector <double> m, int j);
    void takeAction(int dashValue, int dotValue, int IWS);
    void convertMorseCode(string morseCodeParameter);
    void displayContent();
};

#endif /* decimate_hpp */
```

Decimate.cpp:

This file is included in the decimate function using the code line:

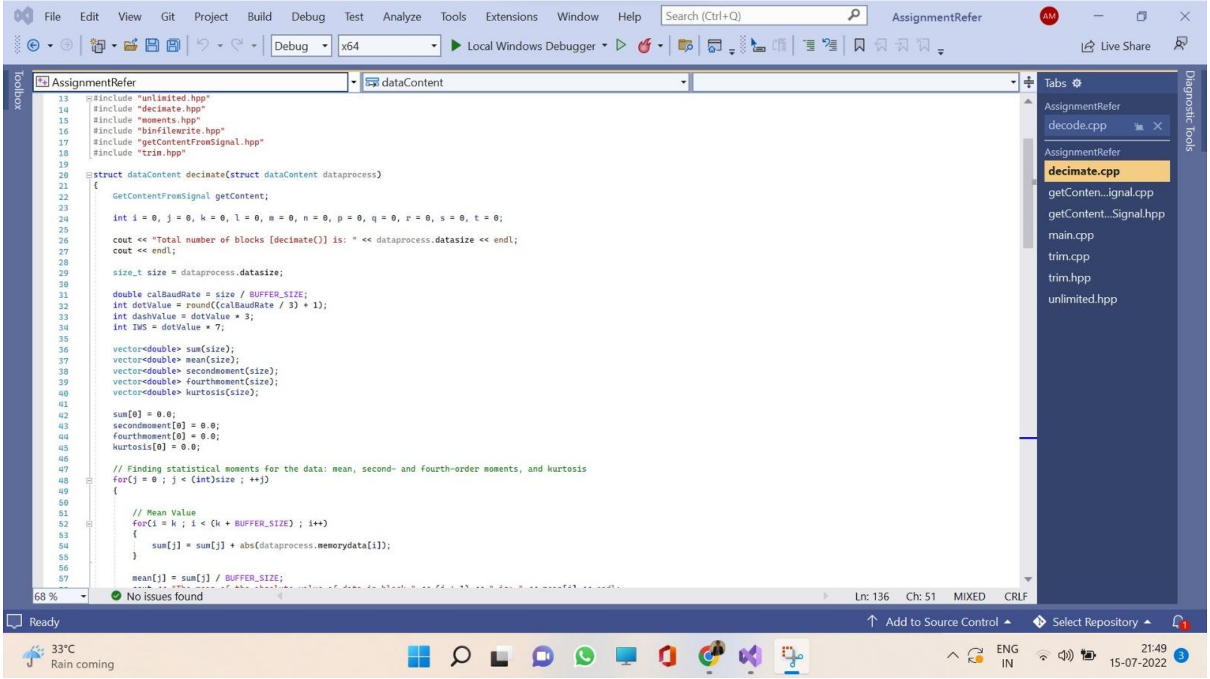
#include “getContentFromSignal.hpp”

So, as the data retrieved can be worked upon. decimate.cpp is then again modified and this getContentFromSignal is called in the decimate.cpp sourcefile.

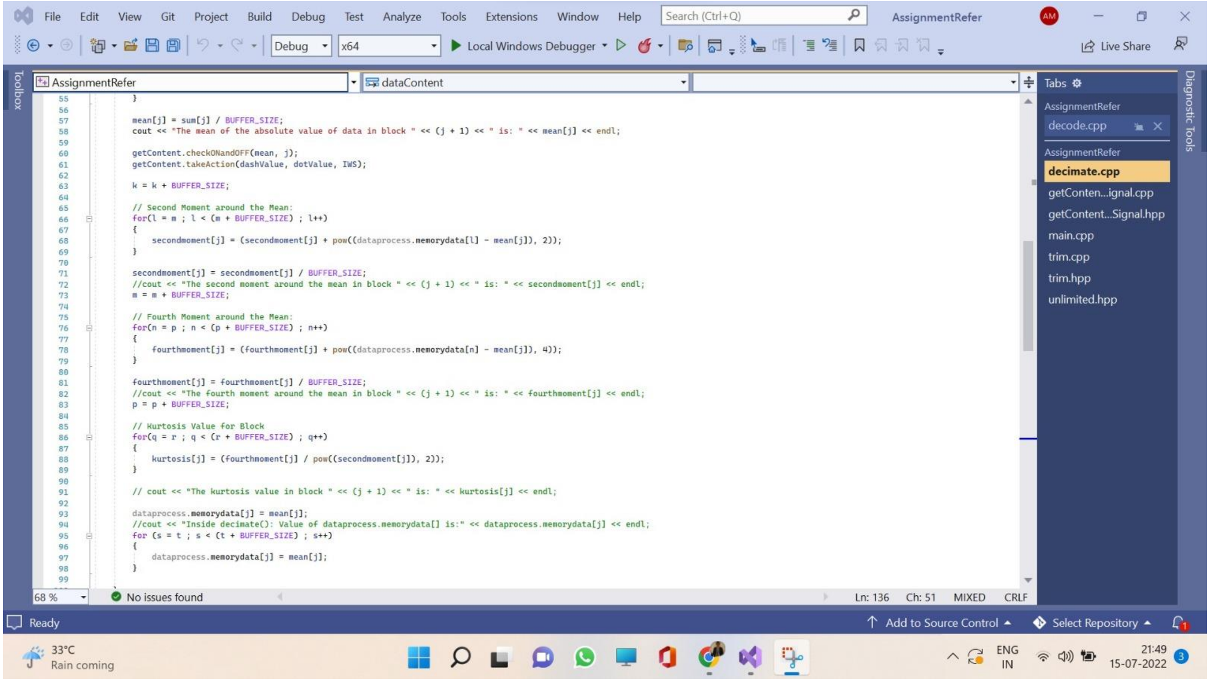
After the successful execution of this file, the program can:

- read the discrete signals
- convert to ON & OFF using the if/else
- convert the combination 1s and 0s to dits and dahs
- then convert the dits and dahs to English alphabets using the listofMorse & iterator.

The final code for decimate file would be:



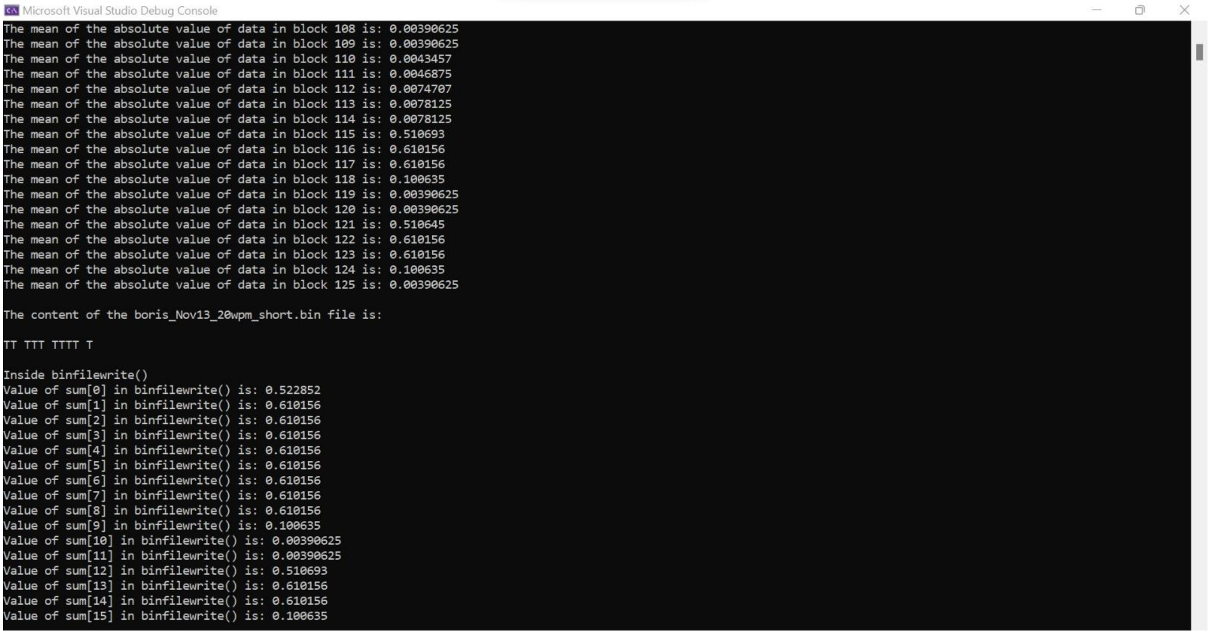
```cpp
#include "unlimited.hpp"
#include "decimate.hpp"
#include "moments.hpp"
#include "binfilewrite.hpp"
#include "getContentFromSignal.hpp"
#include "trim.hpp"

struct dataContent decimate(struct dataContent dataprocess)
{
    GetContentFromSignal getContent;

    int i = 0, j = 0, k = 0, l = 0, m = 0, n = 0, p = 0, q = 0, r = 0, s = 0, t = 0;

    cout << "Total number of blocks [decimate()] is: " << dataprocess.datasize << endl;
    cout << endl;

    size_t size = dataprocess.datasize;

    double calBaudRate = size / BUFFER_SIZE;
    int dotValue = round((calBaudRate / 3) + 1);
    int dashValue = dotValue * 3;
    int IWS = dotValue * 7;

    vector<double> sum(size);
    vector<double> mean(size);
    vector<double> secondmoment(size);
    vector<double> fourthmoment(size);
    vector<double> kurtosis(size);

    sum[0] = 0.0;
    secondmoment[0] = 0.0;
    fourthmoment[0] = 0.0;
    kurtosis[0] = 0.0;

    // Finding statistical moments for the data: mean, second- and fourth-order moments, and kurtosis
    for(j = 0 ; j < (int)size ; ++j)
    {

        // Mean Value
        for(i = k ; i < (k + BUFFER_SIZE) ; i++)
        {
            sum[j] = sum[j] + abs(dataprocess.memorydata[i]);
        }

        mean[j] = sum[j] / BUFFER_SIZE;
```



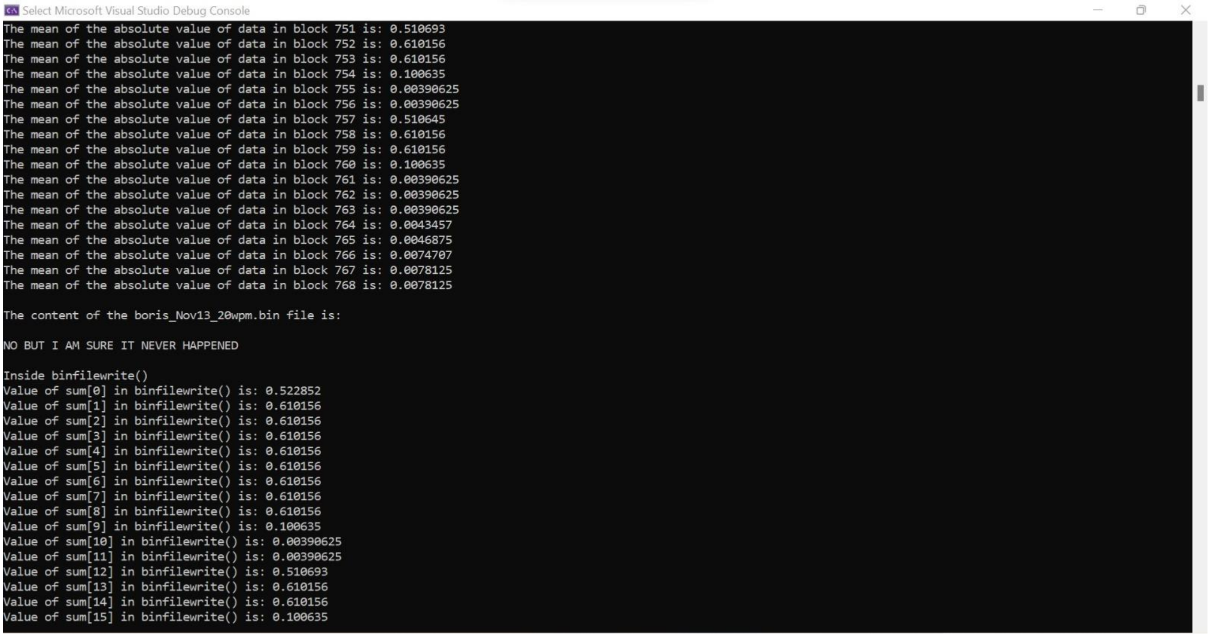
```cpp
        }

        mean[j] = sum[j] / BUFFER_SIZE;
        cout << "The mean of the absolute value of data in block " << (j + 1) << " is: " << mean[j] << endl;

        getContent.checkONandOFF(mean, j);
        getContent.takeAction(dashValue, dotValue, IWS);

        k = k + BUFFER_SIZE;

        // Second Moment around the Mean:
        for(l = m ; l < (m + BUFFER_SIZE) ; l++)
        {
            secondmoment[j] = (secondmoment[j] + pow((dataprocess.memorydata[l] - mean[j]), 2));
        }

        secondmoment[j] = secondmoment[j] / BUFFER_SIZE;
        //cout << "The second moment around the mean in block " << (j + 1) << " is: " << secondmoment[j] << endl;
        m = m + BUFFER_SIZE;

        // Fourth Moment around the Mean:
        for(n = p ; n < (p + BUFFER_SIZE) ; n++)
        {
            fourthmoment[j] = (fourthmoment[j] + pow((dataprocess.memorydata[n] - mean[j]), 4));
        }

        fourthmoment[j] = fourthmoment[j] / BUFFER_SIZE;
        //cout << "The fourth moment around the mean in block " << (j + 1) << " is: " << fourthmoment[j] << endl;
        p = p + BUFFER_SIZE;

        // Kurtosis Value for Block
        for(q = r ; q < (r + BUFFER_SIZE) ; q++)
        {
            kurtosis[j] = (fourthmoment[j] / pow((secondmoment[j]), 2));
        }

        // cout << "The kurtosis value in block " << (j + 1) << " is: " << kurtosis[j] << endl;

        dataprocess.memorydata[j] = mean[j];
        //cout << "Inside decimate(): Value of dataprocess.memorydata[] is:" << dataprocess.memorydata[j] << endl;
        for (s = t ; s < (t + BUFFER_SIZE) ; s++)
        {
            dataprocess.memorydata[j] = mean[j];
        }

```

Final Outputs of the binary files:

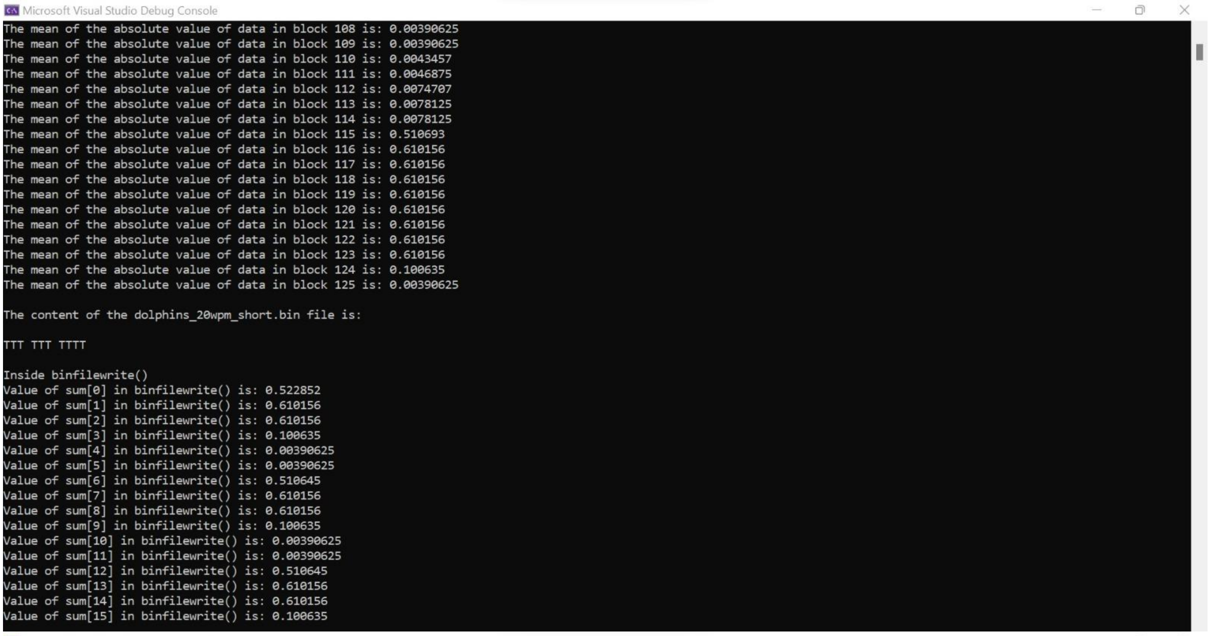
1. dolphins_20wpm.bin
2. dolphins_20wpm_short.bin
3. boris_Nov13_20wpm.bin
4. boris_Nov13_20wpm_short.bin
5. dolphins_10wpm.bin
6. dolphins_10wpm_short.bin



```
The mean of the absolute value of data in block 108 is: 0.00390625
The mean of the absolute value of data in block 109 is: 0.00390625
The mean of the absolute value of data in block 110 is: 0.0043457
The mean of the absolute value of data in block 111 is: 0.0046875
The mean of the absolute value of data in block 112 is: 0.0074707
The mean of the absolute value of data in block 113 is: 0.0078125
The mean of the absolute value of data in block 114 is: 0.0078125
The mean of the absolute value of data in block 115 is: 0.510693
The mean of the absolute value of data in block 116 is: 0.610156
The mean of the absolute value of data in block 117 is: 0.610156
The mean of the absolute value of data in block 118 is: 0.100635
The mean of the absolute value of data in block 119 is: 0.00390625
The mean of the absolute value of data in block 120 is: 0.00390625
The mean of the absolute value of data in block 121 is: 0.510645
The mean of the absolute value of data in block 122 is: 0.610156
The mean of the absolute value of data in block 123 is: 0.610156
The mean of the absolute value of data in block 124 is: 0.100635
The mean of the absolute value of data in block 125 is: 0.00390625

The content of the boris_Nov13_20wpm_short.bin file is:

TT TTT TTTT T

Inside binfilewrite()
Value of sum[0] in binfilewrite() is: 0.522852
Value of sum[1] in binfilewrite() is: 0.610156
Value of sum[2] in binfilewrite() is: 0.610156
Value of sum[3] in binfilewrite() is: 0.610156
Value of sum[4] in binfilewrite() is: 0.610156
Value of sum[5] in binfilewrite() is: 0.610156
Value of sum[6] in binfilewrite() is: 0.610156
Value of sum[7] in binfilewrite() is: 0.610156
Value of sum[8] in binfilewrite() is: 0.610156
Value of sum[9] in binfilewrite() is: 0.100635
Value of sum[10] in binfilewrite() is: 0.00390625
Value of sum[11] in binfilewrite() is: 0.00390625
Value of sum[12] in binfilewrite() is: 0.510693
Value of sum[13] in binfilewrite() is: 0.610156
Value of sum[14] in binfilewrite() is: 0.610156
Value of sum[15] in binfilewrite() is: 0.100635
```

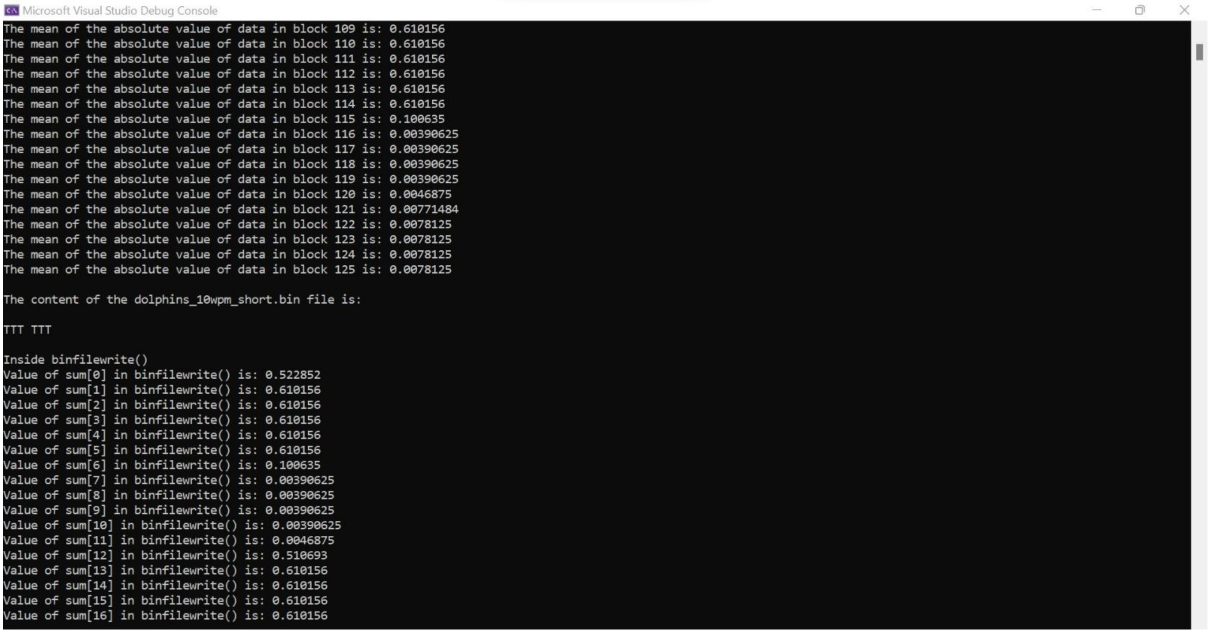


```
The mean of the absolute value of data in block 751 is: 0.510693
The mean of the absolute value of data in block 752 is: 0.610156
The mean of the absolute value of data in block 753 is: 0.610156
The mean of the absolute value of data in block 754 is: 0.100635
The mean of the absolute value of data in block 755 is: 0.00390625
The mean of the absolute value of data in block 756 is: 0.00390625
The mean of the absolute value of data in block 757 is: 0.510645
The mean of the absolute value of data in block 758 is: 0.610156
The mean of the absolute value of data in block 759 is: 0.610156
The mean of the absolute value of data in block 760 is: 0.100635
The mean of the absolute value of data in block 761 is: 0.00390625
The mean of the absolute value of data in block 762 is: 0.00390625
The mean of the absolute value of data in block 763 is: 0.00390625
The mean of the absolute value of data in block 764 is: 0.0043457
The mean of the absolute value of data in block 765 is: 0.0046875
The mean of the absolute value of data in block 766 is: 0.0074707
The mean of the absolute value of data in block 767 is: 0.0078125
The mean of the absolute value of data in block 768 is: 0.0078125

The content of the boris_Nov13_20wpm.bin file is:

NO BUT I AM SURE IT NEVER HAPPENED

Inside binfilewrite()
Value of sum[0] in binfilewrite() is: 0.522852
Value of sum[1] in binfilewrite() is: 0.610156
Value of sum[2] in binfilewrite() is: 0.610156
Value of sum[3] in binfilewrite() is: 0.610156
Value of sum[4] in binfilewrite() is: 0.610156
Value of sum[5] in binfilewrite() is: 0.610156
Value of sum[6] in binfilewrite() is: 0.610156
Value of sum[7] in binfilewrite() is: 0.610156
Value of sum[8] in binfilewrite() is: 0.610156
Value of sum[9] in binfilewrite() is: 0.100635
Value of sum[10] in binfilewrite() is: 0.00390625
Value of sum[11] in binfilewrite() is: 0.00390625
Value of sum[12] in binfilewrite() is: 0.510693
Value of sum[13] in binfilewrite() is: 0.610156
Value of sum[14] in binfilewrite() is: 0.610156
Value of sum[15] in binfilewrite() is: 0.100635
```



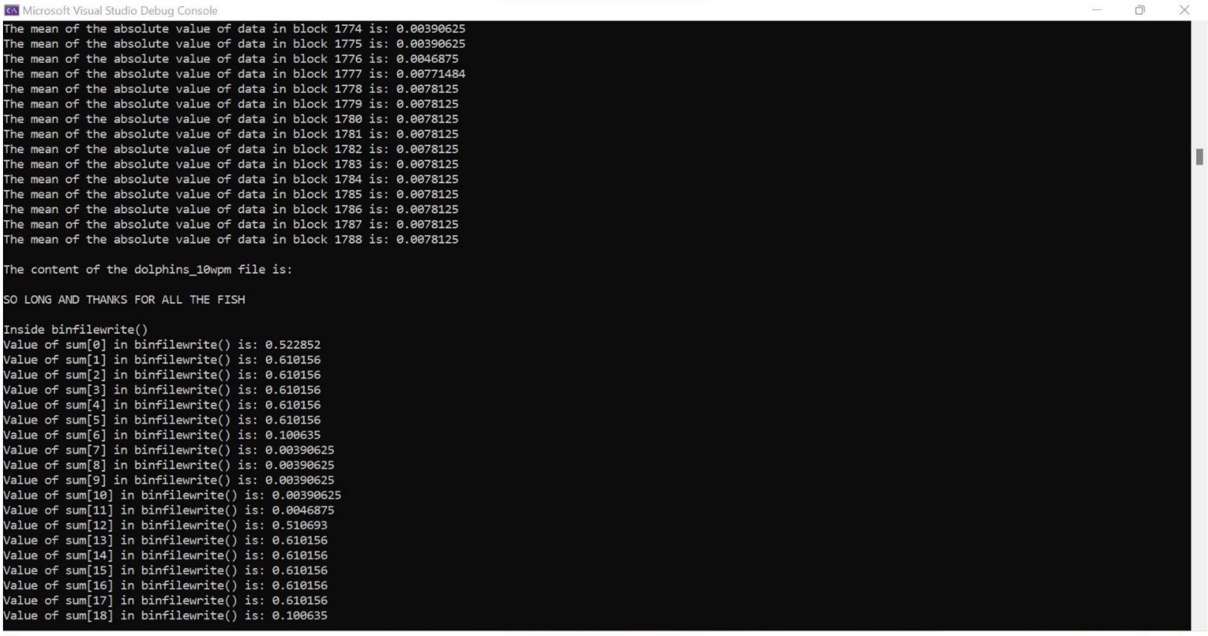
Microsoft Visual Studio Debug Console

```
The mean of the absolute value of data in block 108 is: 0.00390625
The mean of the absolute value of data in block 109 is: 0.00390625
The mean of the absolute value of data in block 110 is: 0.0043457
The mean of the absolute value of data in block 111 is: 0.0046875
The mean of the absolute value of data in block 112 is: 0.0074707
The mean of the absolute value of data in block 113 is: 0.0078125
The mean of the absolute value of data in block 114 is: 0.0078125
The mean of the absolute value of data in block 115 is: 0.510693
The mean of the absolute value of data in block 116 is: 0.610156
The mean of the absolute value of data in block 117 is: 0.610156
The mean of the absolute value of data in block 118 is: 0.610156
The mean of the absolute value of data in block 119 is: 0.610156
The mean of the absolute value of data in block 120 is: 0.610156
The mean of the absolute value of data in block 121 is: 0.610156
The mean of the absolute value of data in block 122 is: 0.610156
The mean of the absolute value of data in block 123 is: 0.610156
The mean of the absolute value of data in block 124 is: 0.100635
The mean of the absolute value of data in block 125 is: 0.00390625

The content of the dolphins_20wpm_short.bin file is:

TTT TTT TTTT

Inside binfilewrite()
Value of sum[0] in binfilewrite() is: 0.522852
Value of sum[1] in binfilewrite() is: 0.610156
Value of sum[2] in binfilewrite() is: 0.610156
Value of sum[3] in binfilewrite() is: 0.100635
Value of sum[4] in binfilewrite() is: 0.00390625
Value of sum[5] in binfilewrite() is: 0.00390625
Value of sum[6] in binfilewrite() is: 0.510645
Value of sum[7] in binfilewrite() is: 0.610156
Value of sum[8] in binfilewrite() is: 0.610156
Value of sum[9] in binfilewrite() is: 0.100635
Value of sum[10] in binfilewrite() is: 0.00390625
Value of sum[11] in binfilewrite() is: 0.00390625
Value of sum[12] in binfilewrite() is: 0.510645
Value of sum[13] in binfilewrite() is: 0.610156
Value of sum[14] in binfilewrite() is: 0.610156
Value of sum[15] in binfilewrite() is: 0.100635
```

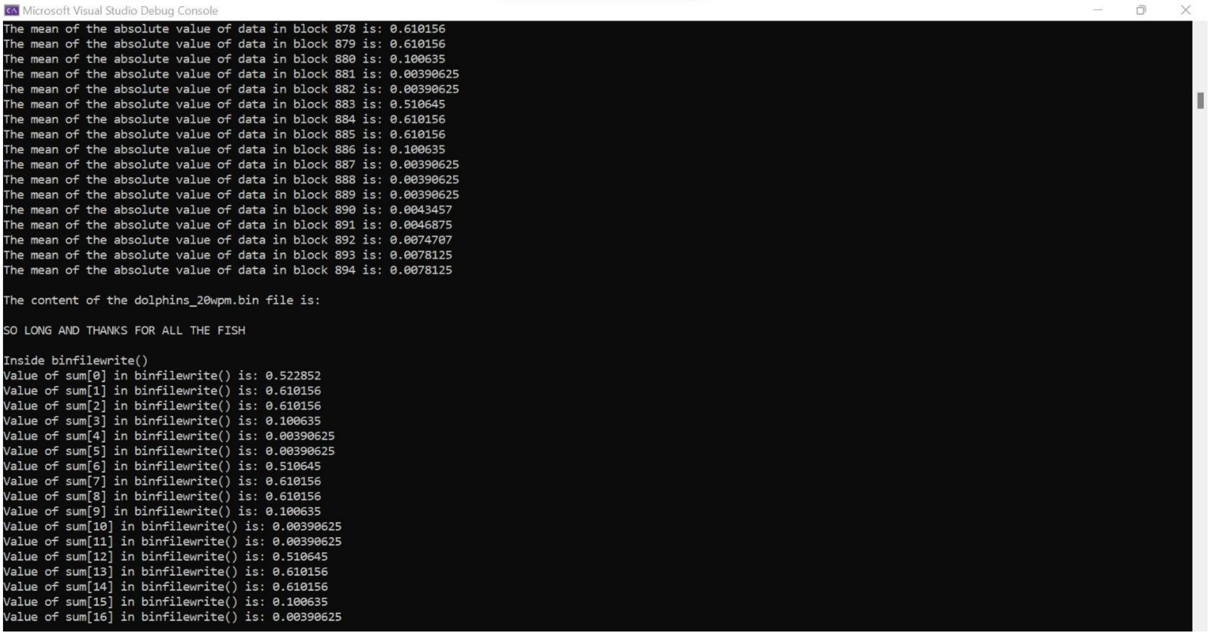


Microsoft Visual Studio Debug Console

```
The mean of the absolute value of data in block 109 is: 0.610156
The mean of the absolute value of data in block 110 is: 0.610156
The mean of the absolute value of data in block 111 is: 0.610156
The mean of the absolute value of data in block 112 is: 0.610156
The mean of the absolute value of data in block 113 is: 0.610156
The mean of the absolute value of data in block 114 is: 0.610156
The mean of the absolute value of data in block 115 is: 0.100635
The mean of the absolute value of data in block 116 is: 0.00390625
The mean of the absolute value of data in block 117 is: 0.00390625
The mean of the absolute value of data in block 118 is: 0.00390625
The mean of the absolute value of data in block 119 is: 0.00390625
The mean of the absolute value of data in block 120 is: 0.0046875
The mean of the absolute value of data in block 121 is: 0.00771484
The mean of the absolute value of data in block 122 is: 0.0078125
The mean of the absolute value of data in block 123 is: 0.0078125
The mean of the absolute value of data in block 124 is: 0.0078125
The mean of the absolute value of data in block 125 is: 0.0078125

The content of the dolphins_10wpm_short.bin file is:

TTT TTT

Inside binfilewrite()
Value of sum[0] in binfilewrite() is: 0.522852
Value of sum[1] in binfilewrite() is: 0.610156
Value of sum[2] in binfilewrite() is: 0.610156
Value of sum[3] in binfilewrite() is: 0.610156
Value of sum[4] in binfilewrite() is: 0.610156
Value of sum[5] in binfilewrite() is: 0.610156
Value of sum[6] in binfilewrite() is: 0.100635
Value of sum[7] in binfilewrite() is: 0.00390625
Value of sum[8] in binfilewrite() is: 0.00390625
Value of sum[9] in binfilewrite() is: 0.00390625
Value of sum[10] in binfilewrite() is: 0.00390625
Value of sum[11] in binfilewrite() is: 0.0046875
Value of sum[12] in binfilewrite() is: 0.510693
Value of sum[13] in binfilewrite() is: 0.610156
Value of sum[14] in binfilewrite() is: 0.610156
Value of sum[15] in binfilewrite() is: 0.610156
Value of sum[16] in binfilewrite() is: 0.610156
```



```
The mean of the absolute value of data in block 1774 is: 0.00390625
The mean of the absolute value of data in block 1775 is: 0.00390625
The mean of the absolute value of data in block 1776 is: 0.0046875
The mean of the absolute value of data in block 1777 is: 0.00771484
The mean of the absolute value of data in block 1778 is: 0.0078125
The mean of the absolute value of data in block 1779 is: 0.0078125
The mean of the absolute value of data in block 1780 is: 0.0078125
The mean of the absolute value of data in block 1781 is: 0.0078125
The mean of the absolute value of data in block 1782 is: 0.0078125
The mean of the absolute value of data in block 1783 is: 0.0078125
The mean of the absolute value of data in block 1784 is: 0.0078125
The mean of the absolute value of data in block 1785 is: 0.0078125
The mean of the absolute value of data in block 1786 is: 0.0078125
The mean of the absolute value of data in block 1787 is: 0.0078125
The mean of the absolute value of data in block 1788 is: 0.0078125

The content of the dolphins_10wpm file is:

SO LONG AND THANKS FOR ALL THE FISH

Inside binfilewrite()
Value of sum[0] in binfilewrite() is: 0.522852
Value of sum[1] in binfilewrite() is: 0.610156
Value of sum[2] in binfilewrite() is: 0.610156
Value of sum[3] in binfilewrite() is: 0.610156
Value of sum[4] in binfilewrite() is: 0.610156
Value of sum[5] in binfilewrite() is: 0.610156
Value of sum[6] in binfilewrite() is: 0.100635
Value of sum[7] in binfilewrite() is: 0.00390625
Value of sum[8] in binfilewrite() is: 0.00390625
Value of sum[9] in binfilewrite() is: 0.00390625
Value of sum[10] in binfilewrite() is: 0.00390625
Value of sum[11] in binfilewrite() is: 0.0046875
Value of sum[12] in binfilewrite() is: 0.510693
Value of sum[13] in binfilewrite() is: 0.610156
Value of sum[14] in binfilewrite() is: 0.610156
Value of sum[15] in binfilewrite() is: 0.610156
Value of sum[16] in binfilewrite() is: 0.610156
Value of sum[17] in binfilewrite() is: 0.610156
Value of sum[18] in binfilewrite() is: 0.100635
```



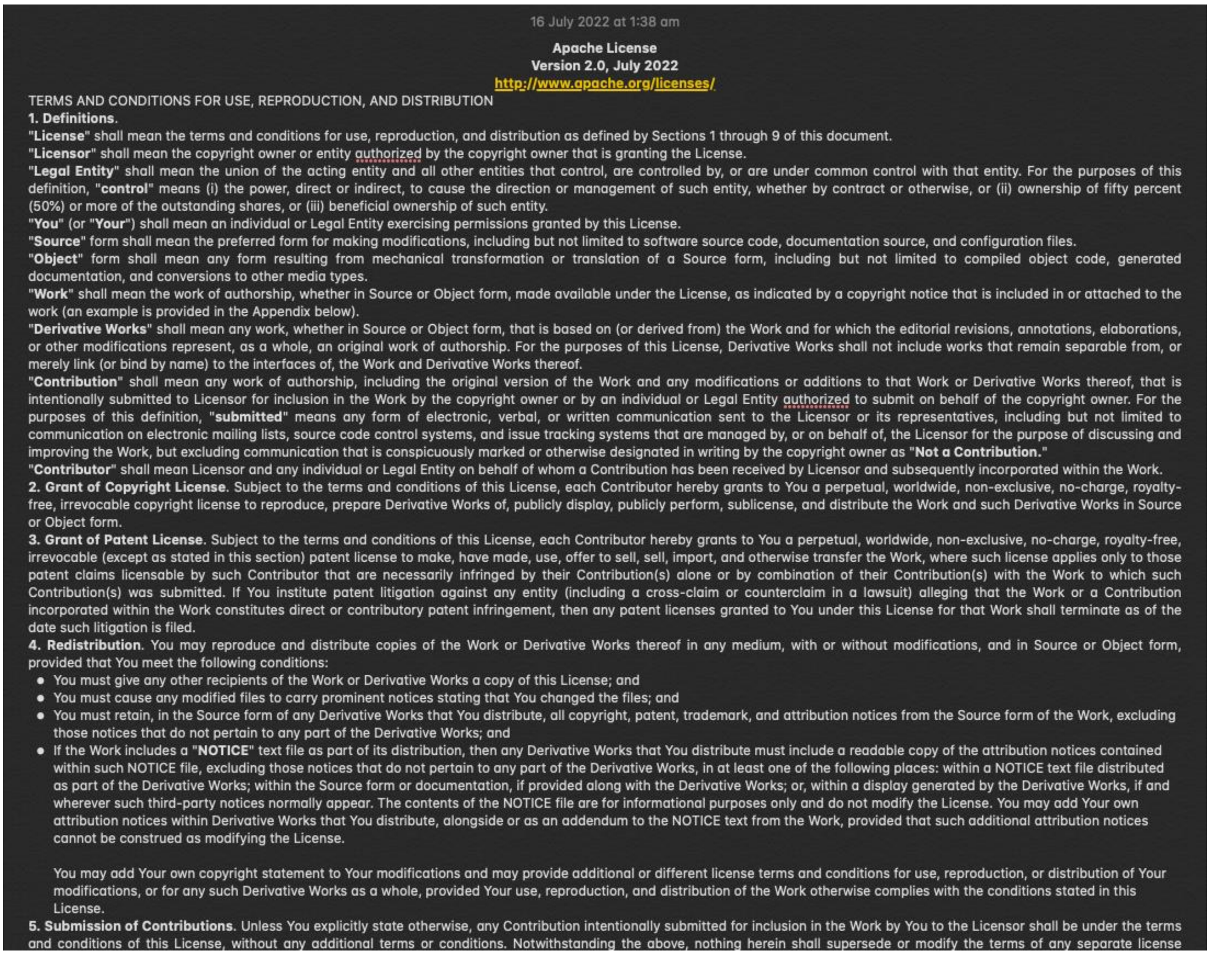
```
The mean of the absolute value of data in block 878 is: 0.610156
The mean of the absolute value of data in block 879 is: 0.610156
The mean of the absolute value of data in block 880 is: 0.100635
The mean of the absolute value of data in block 881 is: 0.00390625
The mean of the absolute value of data in block 882 is: 0.00390625
The mean of the absolute value of data in block 883 is: 0.510645
The mean of the absolute value of data in block 884 is: 0.610156
The mean of the absolute value of data in block 885 is: 0.610156
The mean of the absolute value of data in block 886 is: 0.100635
The mean of the absolute value of data in block 887 is: 0.00390625
The mean of the absolute value of data in block 888 is: 0.00390625
The mean of the absolute value of data in block 889 is: 0.00390625
The mean of the absolute value of data in block 890 is: 0.0043457
The mean of the absolute value of data in block 891 is: 0.0046875
The mean of the absolute value of data in block 892 is: 0.0074707
The mean of the absolute value of data in block 893 is: 0.0078125
The mean of the absolute value of data in block 894 is: 0.0078125

The content of the dolphins_20wpm.bin file is:

SO LONG AND THANKS FOR ALL THE FISH

Inside binfilewrite()
Value of sum[0] in binfilewrite() is: 0.522852
Value of sum[1] in binfilewrite() is: 0.610156
Value of sum[2] in binfilewrite() is: 0.610156
Value of sum[3] in binfilewrite() is: 0.100635
Value of sum[4] in binfilewrite() is: 0.00390625
Value of sum[5] in binfilewrite() is: 0.00390625
Value of sum[6] in binfilewrite() is: 0.510645
Value of sum[7] in binfilewrite() is: 0.610156
Value of sum[8] in binfilewrite() is: 0.610156
Value of sum[9] in binfilewrite() is: 0.100635
Value of sum[10] in binfilewrite() is: 0.00390625
Value of sum[11] in binfilewrite() is: 0.00390625
Value of sum[12] in binfilewrite() is: 0.510645
Value of sum[13] in binfilewrite() is: 0.610156
Value of sum[14] in binfilewrite() is: 0.610156
Value of sum[15] in binfilewrite() is: 0.100635
Value of sum[16] in binfilewrite() is: 0.00390625
```

Task 4:

License and mentioning the terms and conditions for the program used is an essential part of building computer coding.

- They ensure developer's intellectual trade secrets.
- They monitor if any other party is using the code illegally.
- They help users in maintaining a positive relationship between the coder and the vendor.
- They define the clear boundaries of what can be done with the code and what should not be done.

License:



16 July 2022 at 1:38 am

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Version 2.0, July 2022
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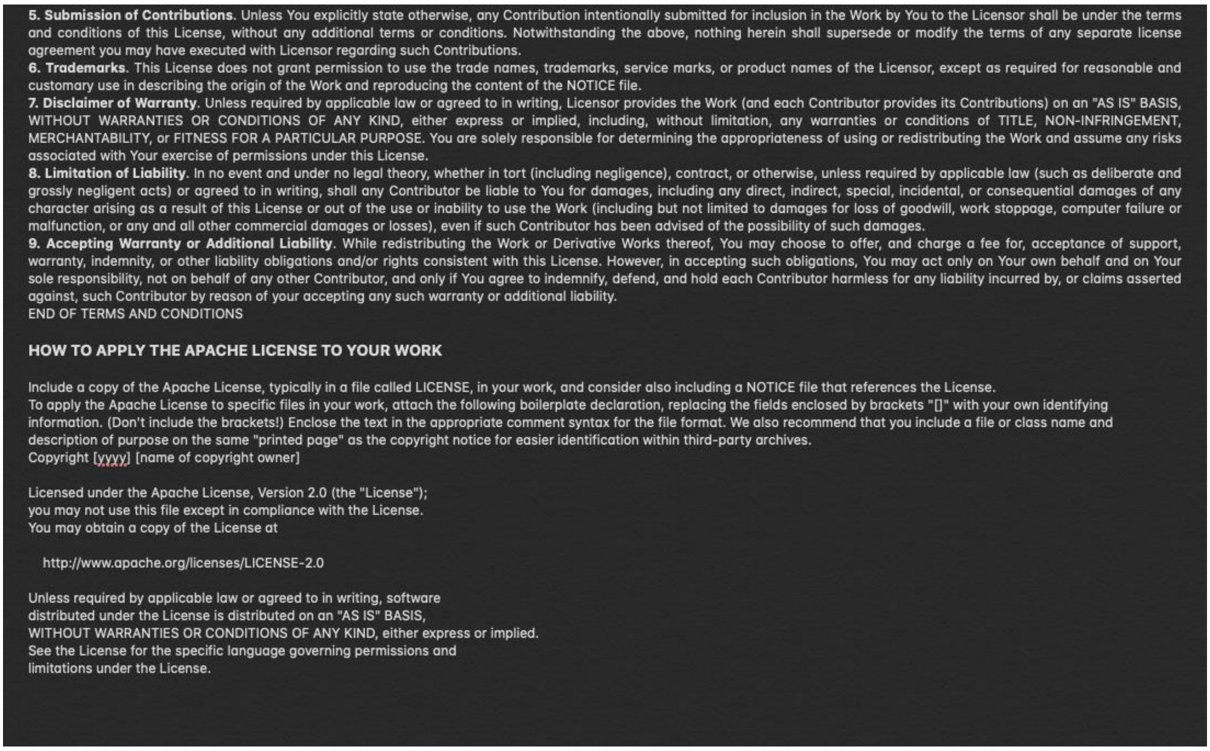

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