ENSF 694 – Summer 2024

Principles of Software Development II

University of Calgary

Lab Assignment 1

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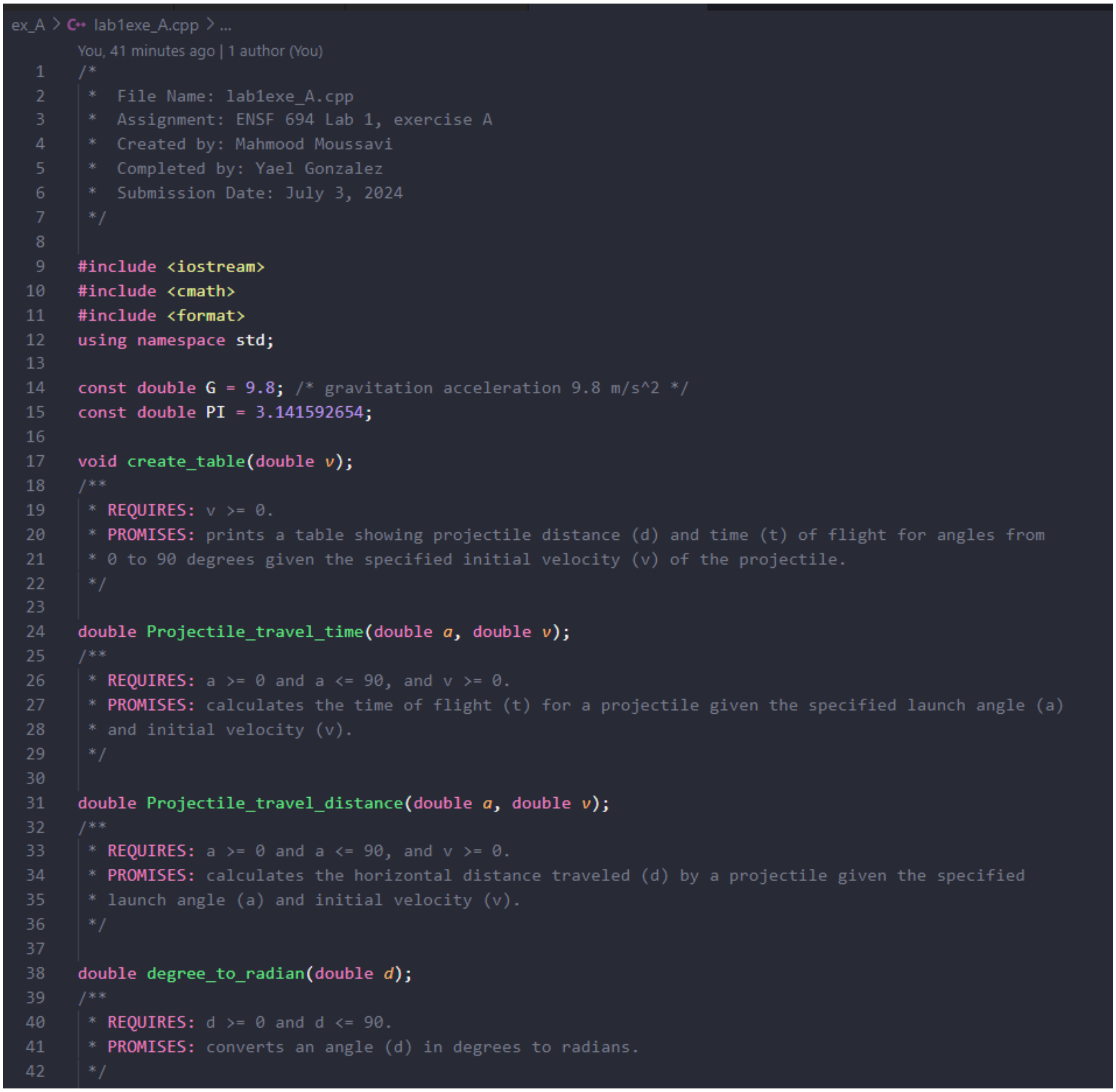
Instructor: M. Moussavi, PhD, Peng

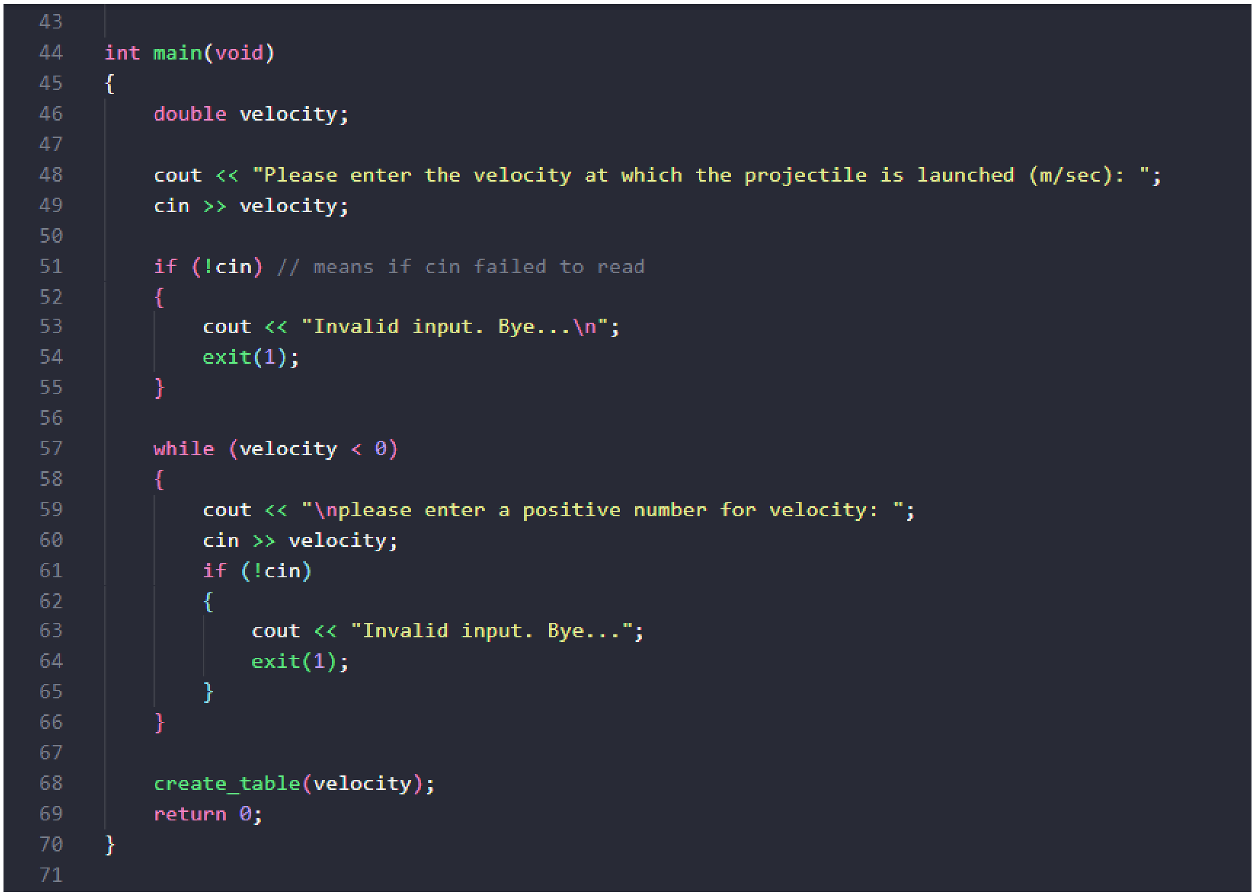
Submission Date: July 3, 2024

Exercise A

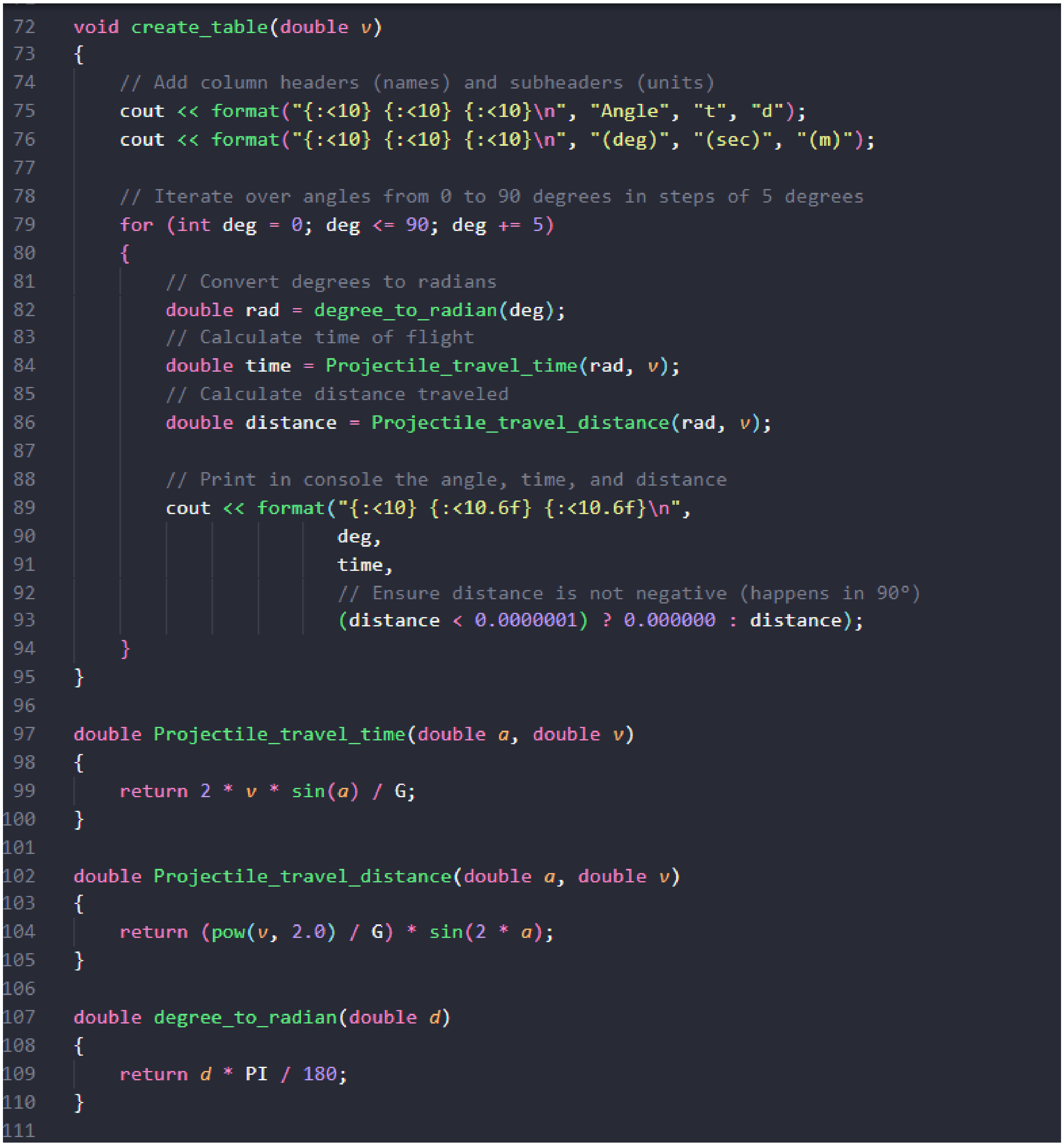
Source Code


ex_A > C++ lab1exe_A.cpp > ...
You, 41 minutes ago | 1 author (You)

```
/*
 *  File Name: lab1exe_A.cpp
 *  Assignment: ENSF 694 Lab 1, exercise A
 *  Created by: Mahmood Moussavi
 *  Completed by: Yael Gonzalez
 *  Submission Date: July 3, 2024
 */

#include <iostream>
#include <cmath>
#include <format>
using namespace std;

const double G = 9.8; /* gravitation acceleration 9.8 m/s^2 */
const double PI = 3.141592654;

void create_table(double v);
/**
 * REQUIRES: v >= 0.
 * PROMISES: prints a table showing projectile distance (d) and time (t) of flight for angles from
 * 0 to 90 degrees given the specified initial velocity (v) of the projectile.
 */

double Projectile_travel_time(double a, double v);
/**
 * REQUIRES: a >= 0 and a <= 90, and v >= 0.
 * PROMISES: calculates the time of flight (t) for a projectile given the specified launch angle (a)
 * and initial velocity (v).
 */

double Projectile_travel_distance(double a, double v);
/**
 * REQUIRES: a >= 0 and a <= 90, and v >= 0.
 * PROMISES: calculates the horizontal distance traveled (d) by a projectile given the specified
 * launch angle (a) and initial velocity (v).
 */

double degree_to_radian(double d);
/**
 * REQUIRES: d >= 0 and d <= 90.
 * PROMISES: converts an angle (d) in degrees to radians.
 */
```

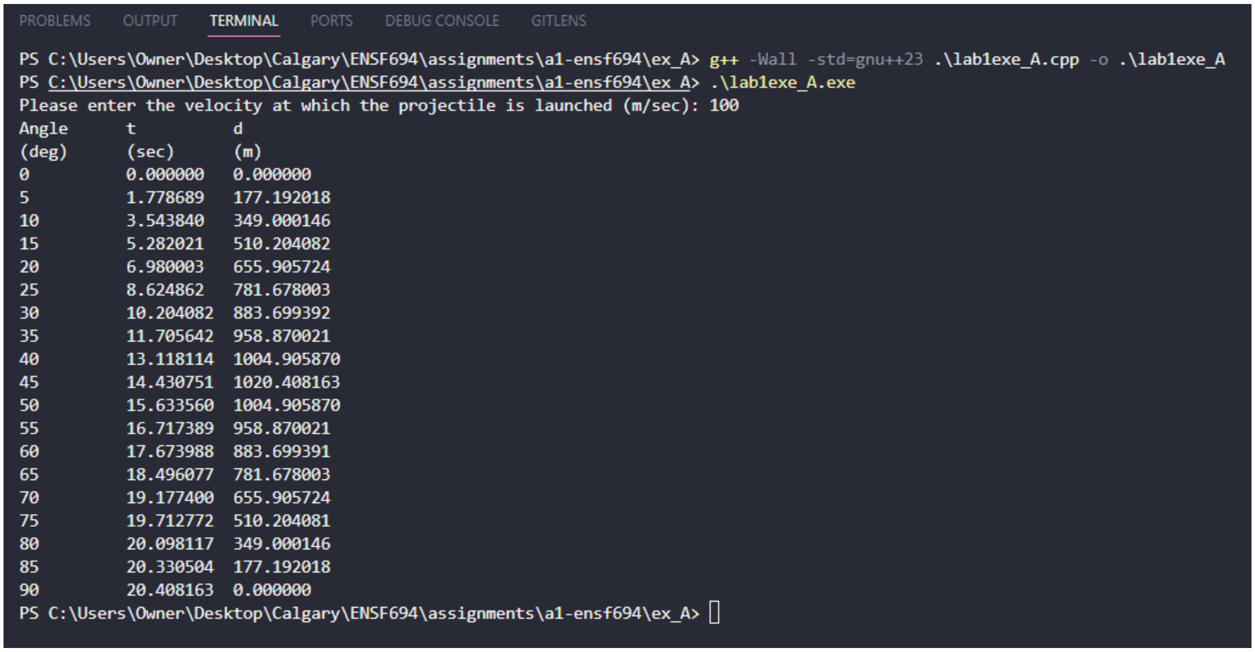


```cpp

int main(void)
{
    double velocity;

    cout << "Please enter the velocity at which the projectile is launched (m/sec): ";
    cin >> velocity;

    if (!cin) // means if cin failed to read
    {
        cout << "Invalid input. Bye...\n";
        exit(1);
    }

    while (velocity < 0)
    {
        cout << "\nplease enter a positive number for velocity: ";
        cin >> velocity;
        if (!cin)
        {
            cout << "Invalid input. Bye...";
            exit(1);
        }
    }

    create_table(velocity);
    return 0;
}

```



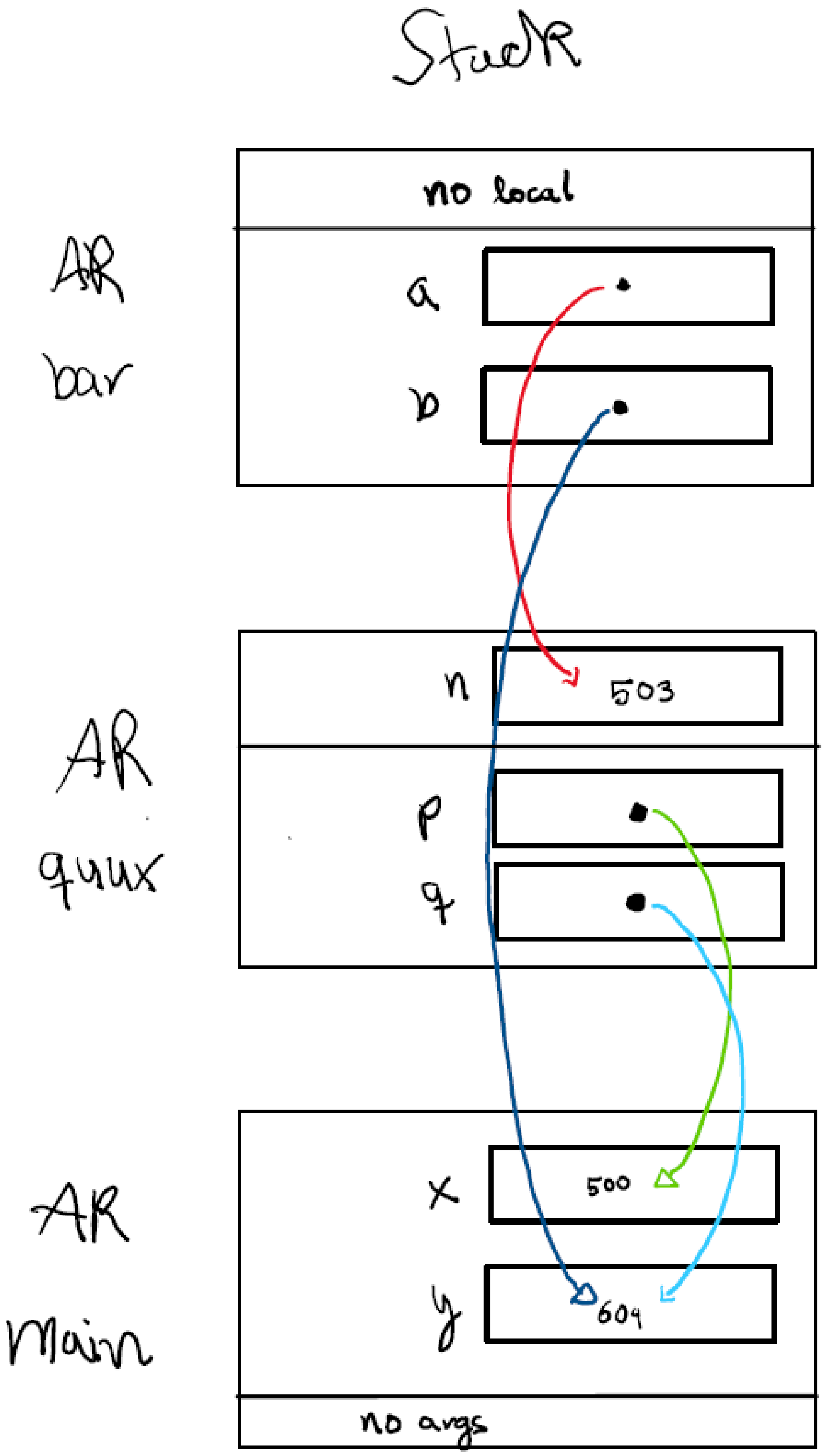
```cpp
void create_table(double v)
{
    // Add column headers (names) and subheaders (units)
    cout << format("{:<10} {:<10} {:<10}\n", "Angle", "t", "d");
    cout << format("{:<10} {:<10} {:<10}\n", "(deg)", "(sec)", "(m)");

    // Iterate over angles from 0 to 90 degrees in steps of 5 degrees
    for (int deg = 0; deg <= 90; deg += 5)
    {
        // Convert degrees to radians
        double rad = degree_to_radian(deg);
        // Calculate time of flight
        double time = Projectile_travel_time(rad, v);
        // Calculate distance traveled
        double distance = Projectile_travel_distance(rad, v);

        // Print in console the angle, time, and distance
        cout << format("{:<10} {:<10.6f} {:<10.6f}\n",
                       deg,
                       time,
                       // Ensure distance is not negative (happens in 90°)
                       (distance < 0.0000001) ? 0.000000 : distance);
    }
}

double Projectile_travel_time(double a, double v)
{
    return 2 * v * sin(a) / G;
}

double Projectile_travel_distance(double a, double v)
{
    return (pow(v, 2.0) / G) * sin(2 * a);
}

double degree_to_radian(double d)
{
    return d * PI / 180;
}

```

Program Output



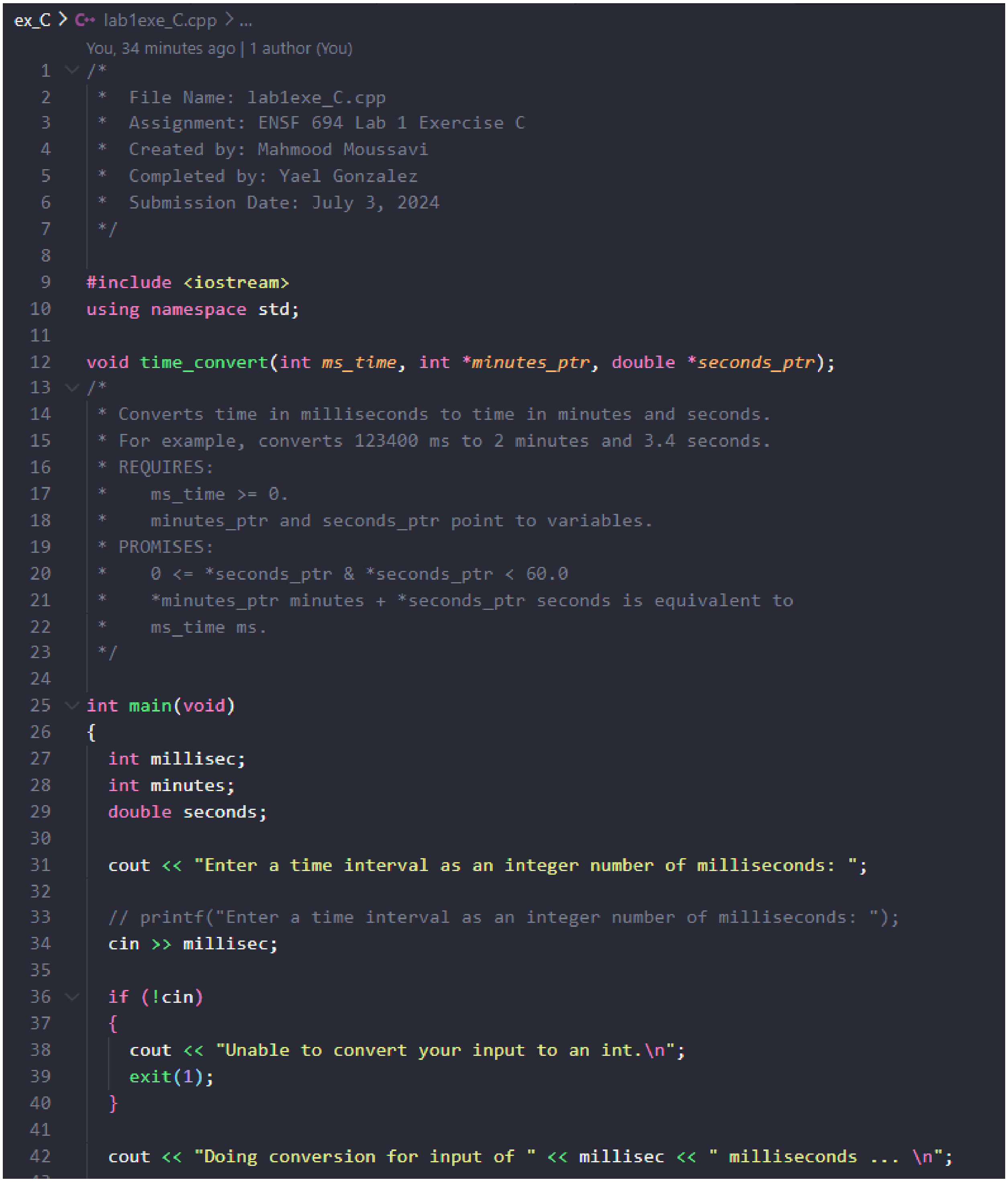
```
PS C:\Users\Owner\Desktop\Calgary\ENSF694\assignments\a1-ensf694\ex_A> g++ -Wall -std=gnu++23 .\lab1exe_A.cpp -o .\lab1exe_A
PS C:\Users\Owner\Desktop\Calgary\ENSF694\assignments\a1-ensf694\ex_A> .\lab1exe_A.exe
Please enter the velocity at which the projectile is launched (m/sec): 100
Angle      t          d
(deg)      (sec)      (m)
0          0.000000   0.000000
5          1.778689   177.192018
10         3.543840   349.000146
15         5.282021   510.204082
20         6.980003   655.905724
25         8.624862   781.678003
30         10.204082  883.699392
35         11.705642  958.870021
40         13.118114  1004.905870
45         14.430751  1020.408163
50         15.633560  1004.905870
55         16.717389  958.870021
60         17.673988  883.699391
65         18.496077  781.678003
70         19.177400  655.905724
75         19.712772  510.204081
80         20.098117  349.000146
85         20.330504  177.192018
90         20.408163  0.000000
PS C:\Users\Owner\Desktop\Calgary\ENSF694\assignments\a1-ensf694\ex_A> 
```

Exercise B – Part II AR diagram

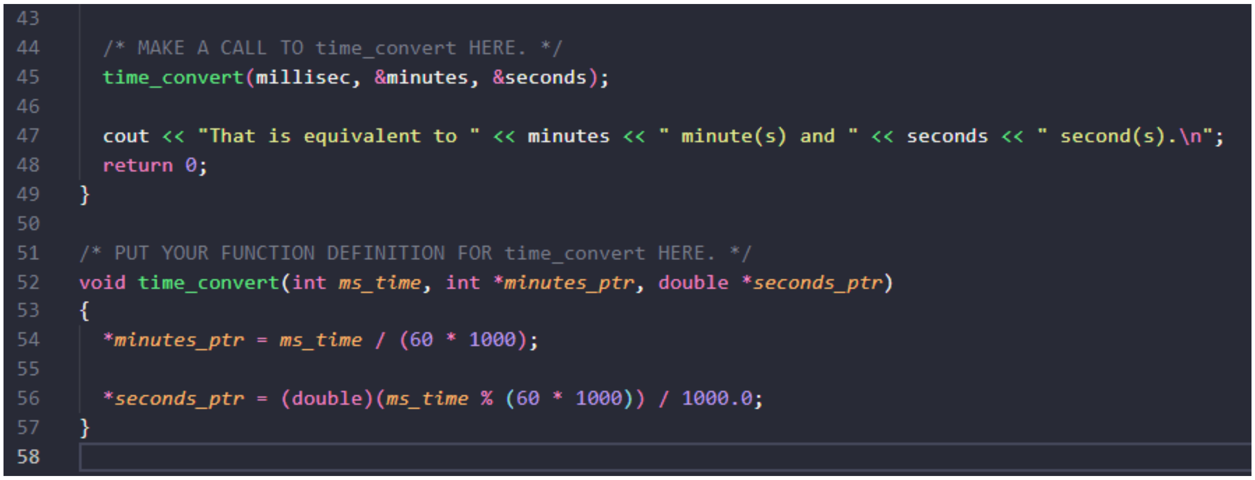


Exercise C

Source Code

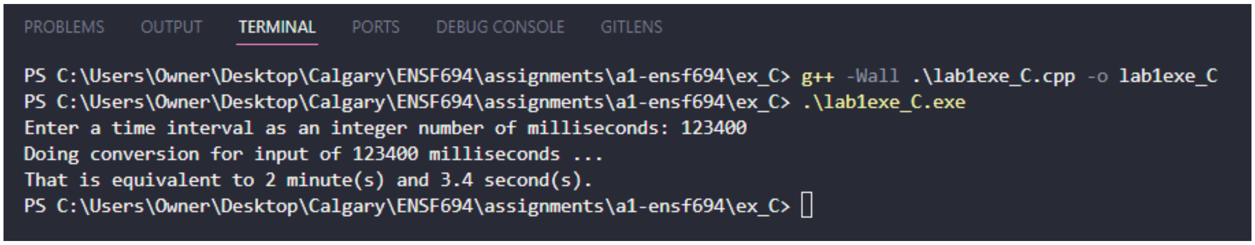

ex_C > lab1exe_C.cpp > ...
You, 34 minutes ago | 1 author (You)

```
/*
 *  File Name: lab1exe_C.cpp
 *  Assignment: ENSF 694 Lab 1 Exercise C
 *  Created by: Mahmood Moussavi
 *  Completed by: Yael Gonzalez
 *  Submission Date: July 3, 2024
 */

#include <iostream>
using namespace std;

void time_convert(int ms_time, int *minutes_ptr, double *seconds_ptr);
/*
 * Converts time in milliseconds to time in minutes and seconds.
 * For example, converts 123400 ms to 2 minutes and 3.4 seconds.
 * REQUIRES:
 *    ms_time >= 0.
 *    minutes_ptr and seconds_ptr point to variables.
 * PROMISES:
 *    0 <= *seconds_ptr & *seconds_ptr < 60.0
 *    *minutes_ptr minutes + *seconds_ptr seconds is equivalent to
 *    ms_time ms.
 */

int main(void)
{
  int millisec;
  int minutes;
  double seconds;

  cout << "Enter a time interval as an integer number of milliseconds: ";

  // printf("Enter a time interval as an integer number of milliseconds: ");
  cin >> millisec;

  if (!cin)
  {
    cout << "Unable to convert your input to an int.\n";
    exit(1);
  }

  cout << "Doing conversion for input of " << millisec << " milliseconds ... \n";
```



```cpp

    /* MAKE A CALL TO time_convert HERE. */
    time_convert(millisec, &minutes, &seconds);

    cout << "That is equivalent to " << minutes << " minute(s) and " << seconds << " second(s).\n";
    return 0;
}

/* PUT YOUR FUNCTION DEFINITION FOR time_convert HERE. */
void time_convert(int ms_time, int *minutes_ptr, double *seconds_ptr)
{
    *minutes_ptr = ms_time / (60 * 1000);

    *seconds_ptr = (double)(ms_time % (60 * 1000)) / 1000.0;
}

```

Program Output

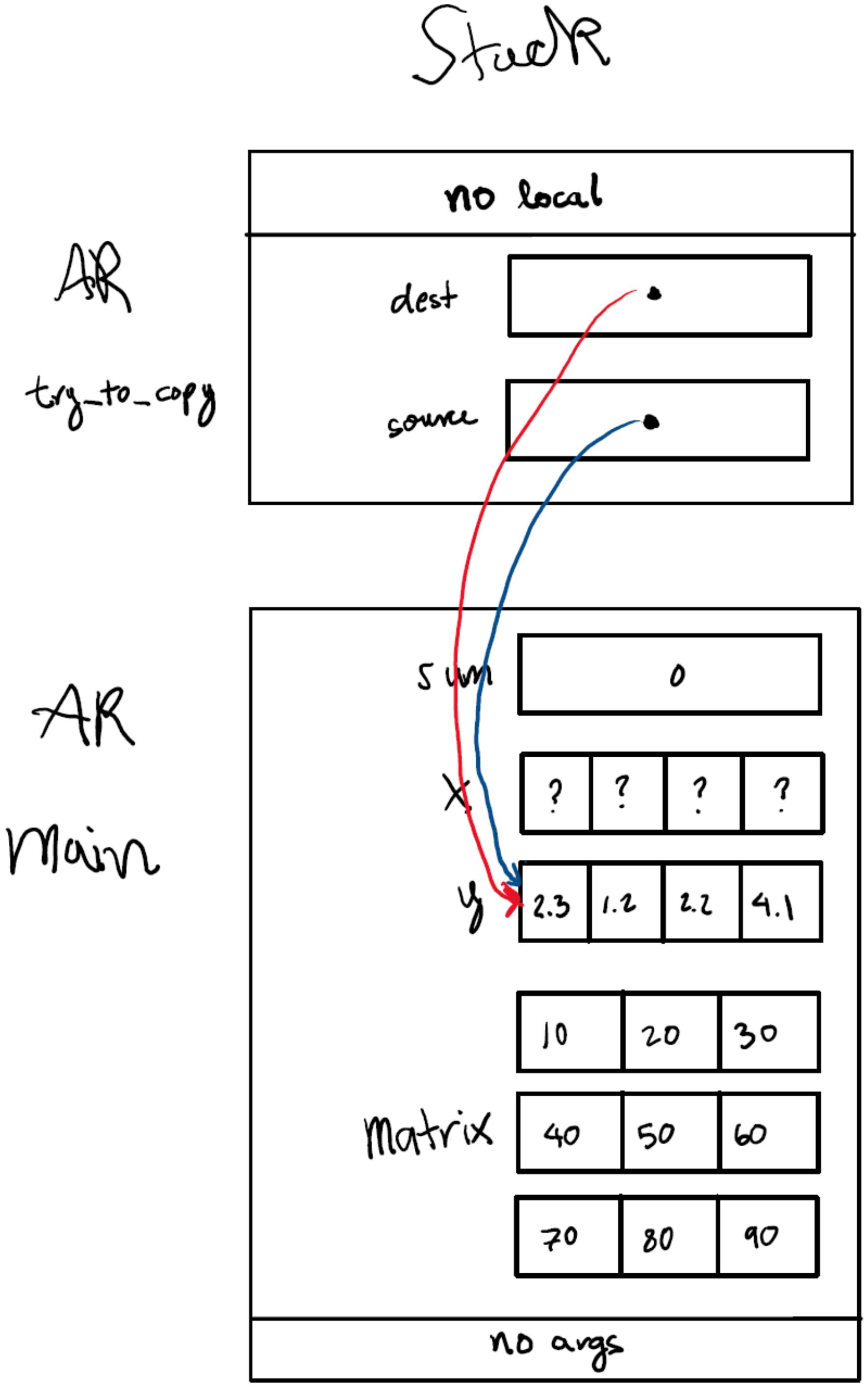


```
PS C:\Users\Owner\Desktop\Calgary\ENSF694\assignments\a1-ensf694\ex_C> g++ -Wall .\lab1exe_C.cpp -o lab1exe_C
PS C:\Users\Owner\Desktop\Calgary\ENSF694\assignments\a1-ensf694\ex_C> .\lab1exe_C.exe
Enter a time interval as an integer number of milliseconds: 123400
Doing conversion for input of 123400 milliseconds ...
That is equivalent to 2 minute(s) and 3.4 second(s).
PS C:\Users\Owner\Desktop\Calgary\ENSF694\assignments\a1-ensf694\ex_C> 
```

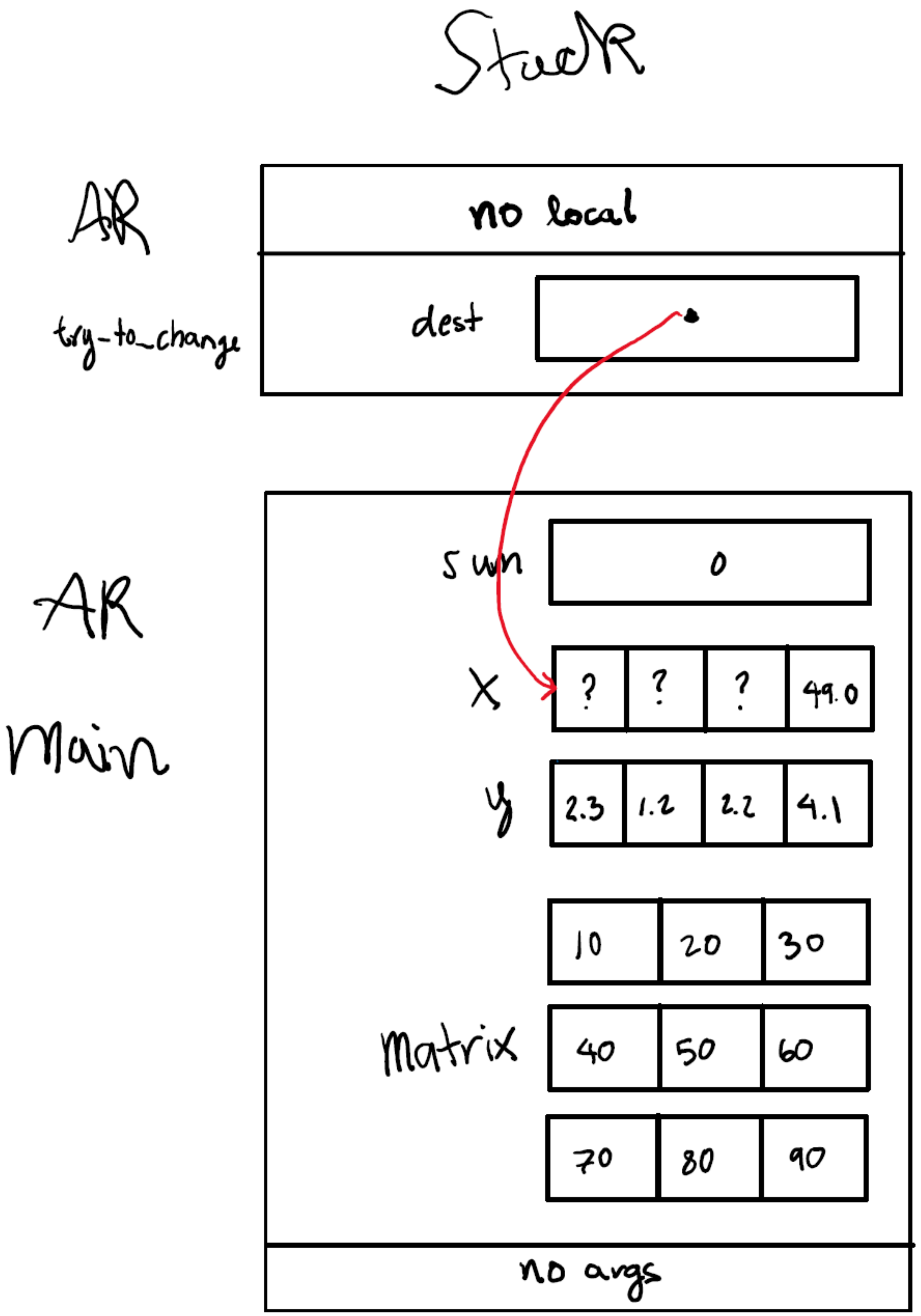
Exercise D

Part I – AR diagrams for points one, two, and three

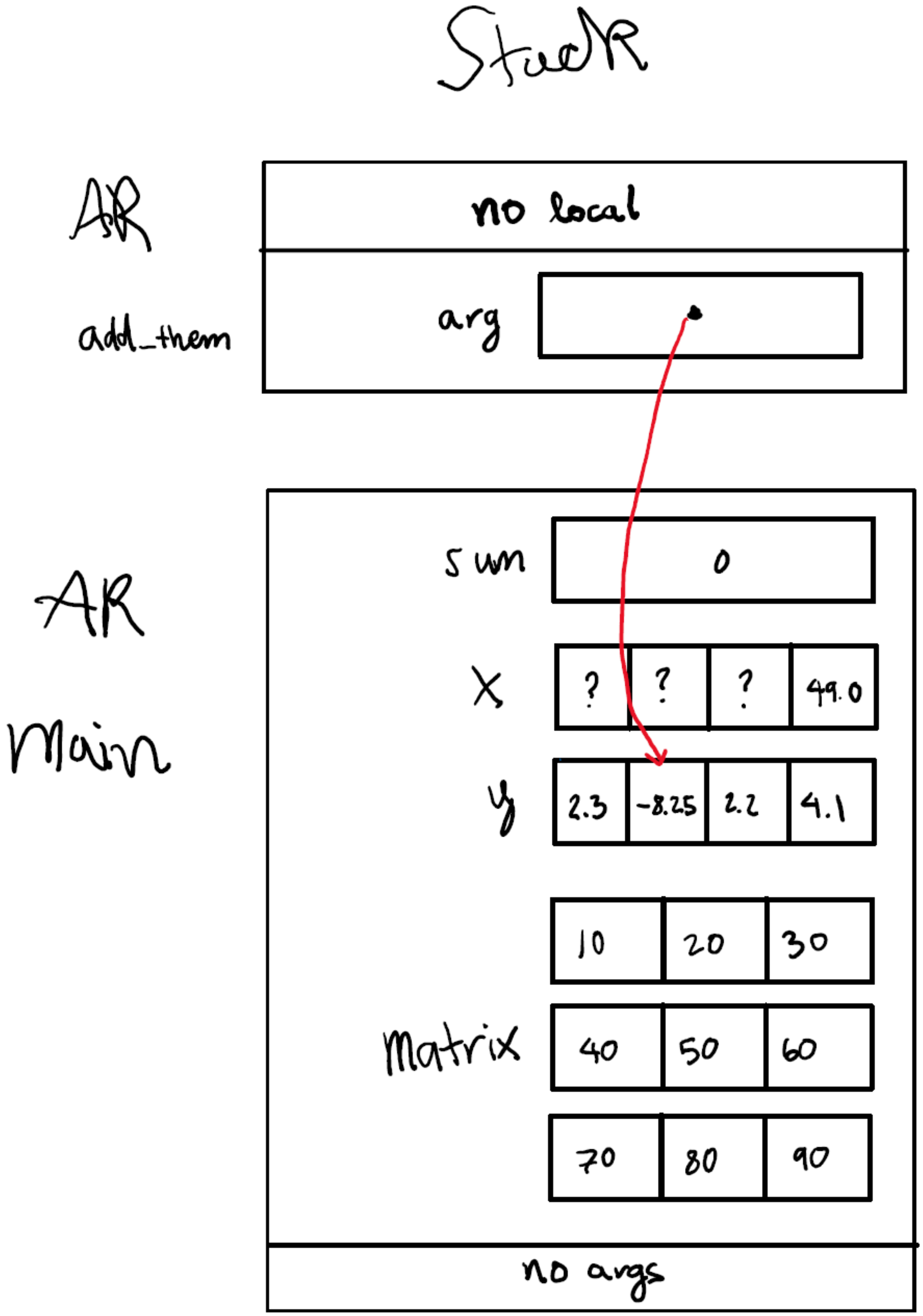
Point One



Point Two

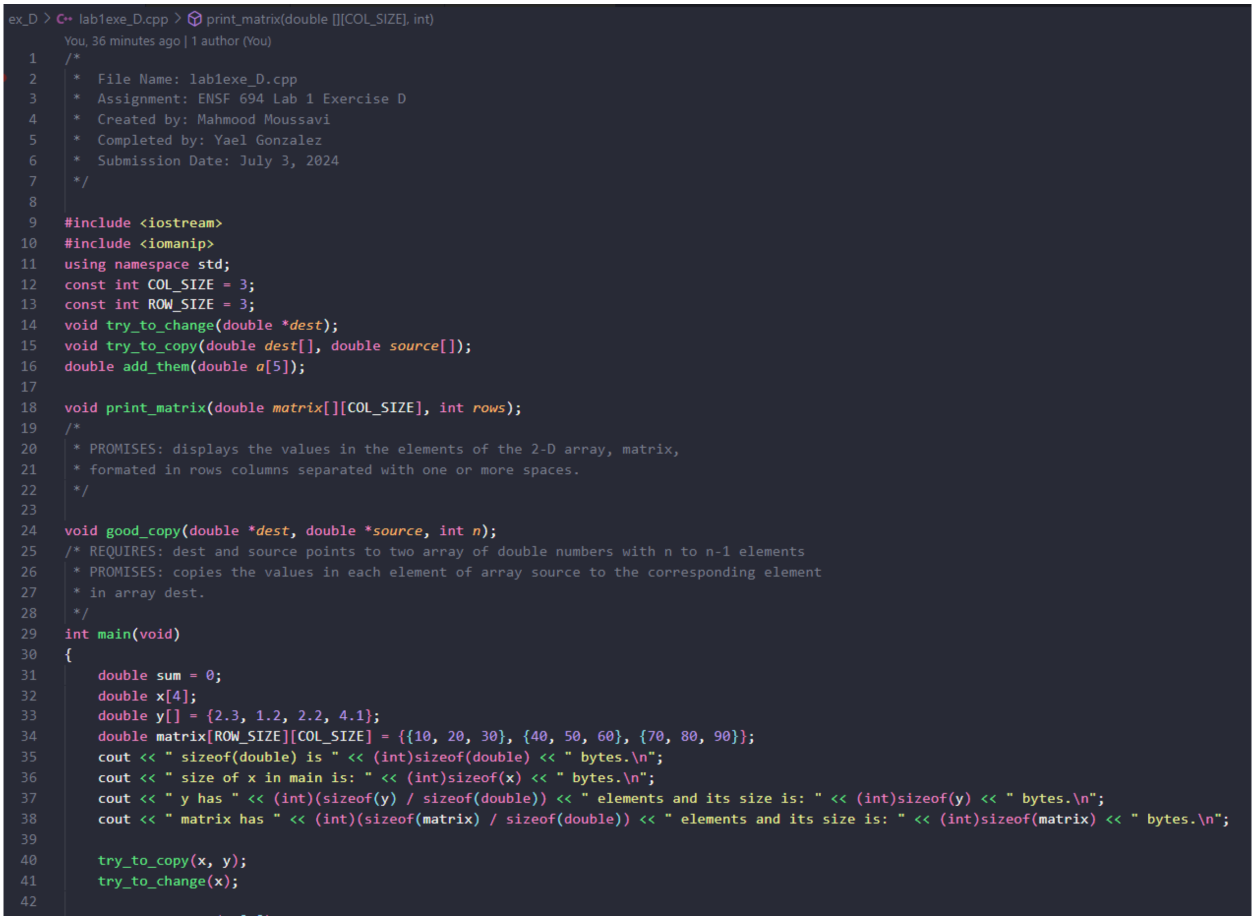

Stack
AR
try-to_change
no local
dest
AR
main
sum
0
x
?
?
?
49.0
y
2.3
1.2
2.2
4.1
matrix
10
20
30
40
50
60
70
80
90
no args

Point Three

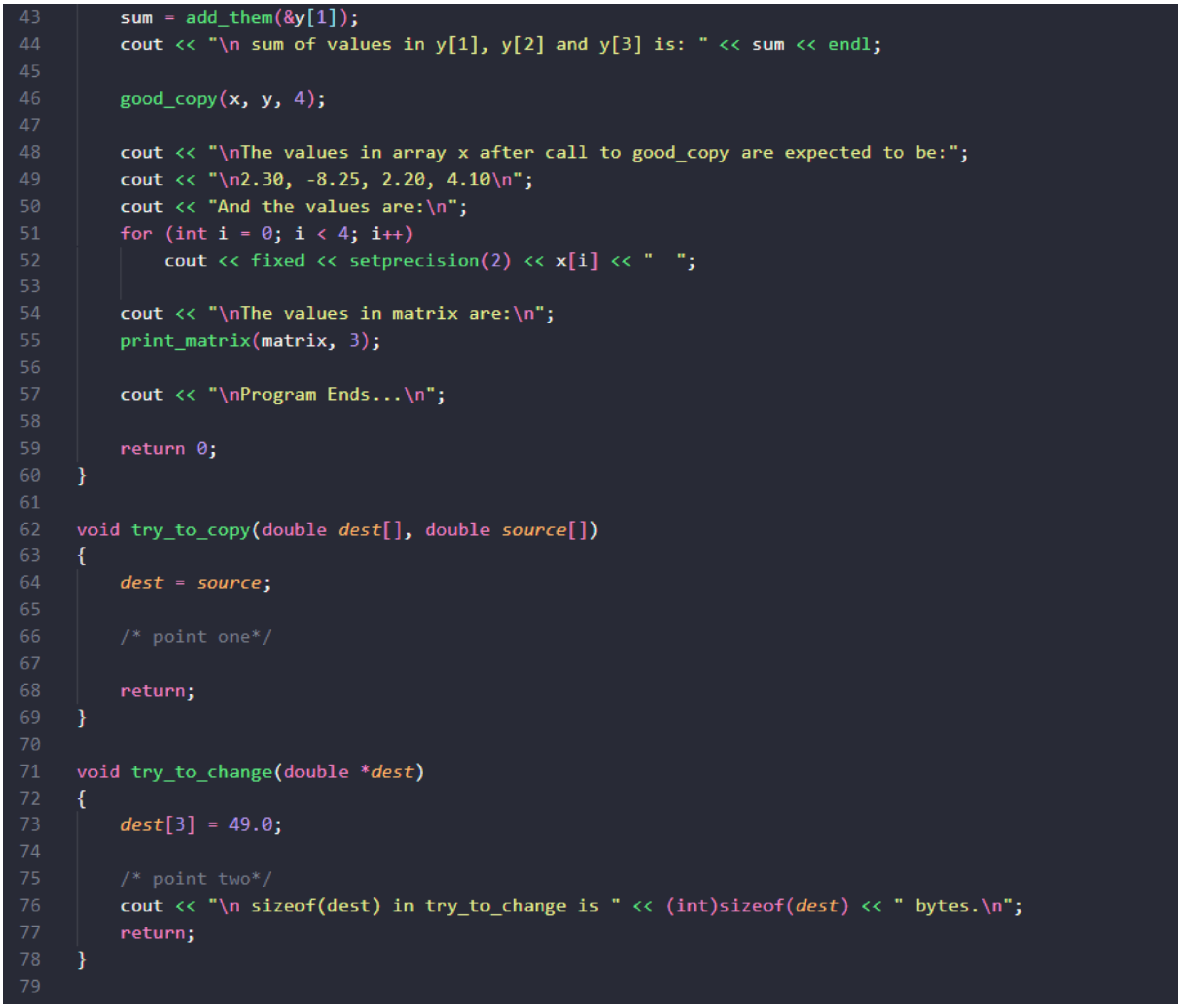

Stack
AR
add_them
no local
arg
AR
Main
sum
0
X
?
?
?
49.0
y
2.3
-8.25
2.2
4.1
Matrix
10
20
30
40
50
60
70
80
90
no args

Part II

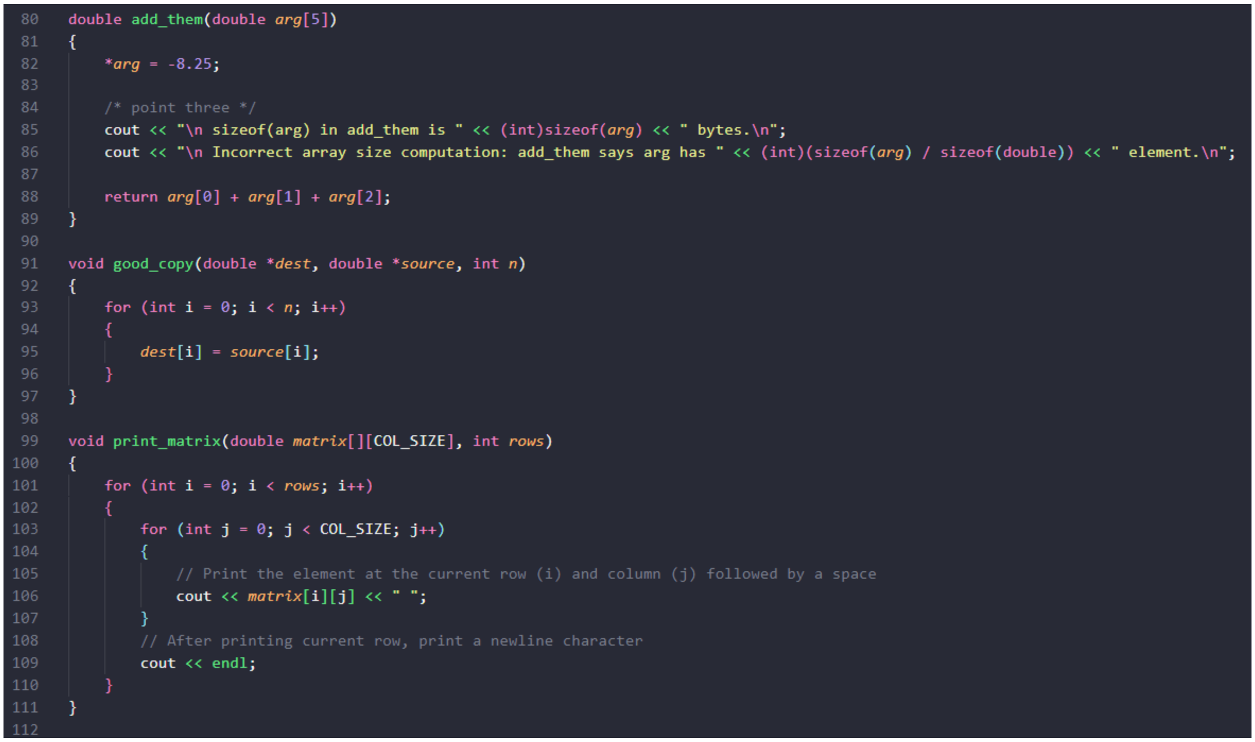
Source Code


ex_D > lab1exe_D.cpp > print_matrix(double [][COL_SIZE], int)
You, 36 minutes ago | 1 author (You)

```cpp
/*
 *  File Name: lab1exe_D.cpp
 *  Assignment: ENSF 694 Lab 1 Exercise D
 *  Created by: Mahmood Moussavi
 *  Completed by: Yael Gonzalez
 *  Submission Date: July 3, 2024
 */

#include <iostream>
#include <iomanip>
using namespace std;
const int COL_SIZE = 3;
const int ROW_SIZE = 3;
void try_to_change(double *dest);
void try_to_copy(double dest[], double source[]);
double add_them(double a[5]);

void print_matrix(double matrix[][COL_SIZE], int rows);
/*
 * PROMISES: displays the values in the elements of the 2-D array, matrix,
 * formated in rows columns separated with one or more spaces.
 */

void good_copy(double *dest, double *source, int n);
/* REQUIRES: dest and source points to two array of double numbers with n to n-1 elements
 * PROMISES: copies the values in each element of array source to the corresponding element
 * in array dest.
 */
int main(void)
{
    double sum = 0;
    double x[4];
    double y[] = {2.3, 1.2, 2.2, 4.1};
    double matrix[ROW_SIZE][COL_SIZE] = {{10, 20, 30}, {40, 50, 60}, {70, 80, 90}};
    cout << " sizeof(double) is " << (int)sizeof(double) << " bytes.\n";
    cout << " size of x in main is: " << (int)sizeof(x) << " bytes.\n";
    cout << " y has " << (int)(sizeof(y) / sizeof(double)) << " elements and its size is: " << (int)sizeof(y) << " bytes.\n";
    cout << " matrix has " << (int)(sizeof(matrix) / sizeof(double)) << " elements and its size is: " << (int)sizeof(matrix) << " bytes.\n";

    try_to_copy(x, y);
    try_to_change(x);

```

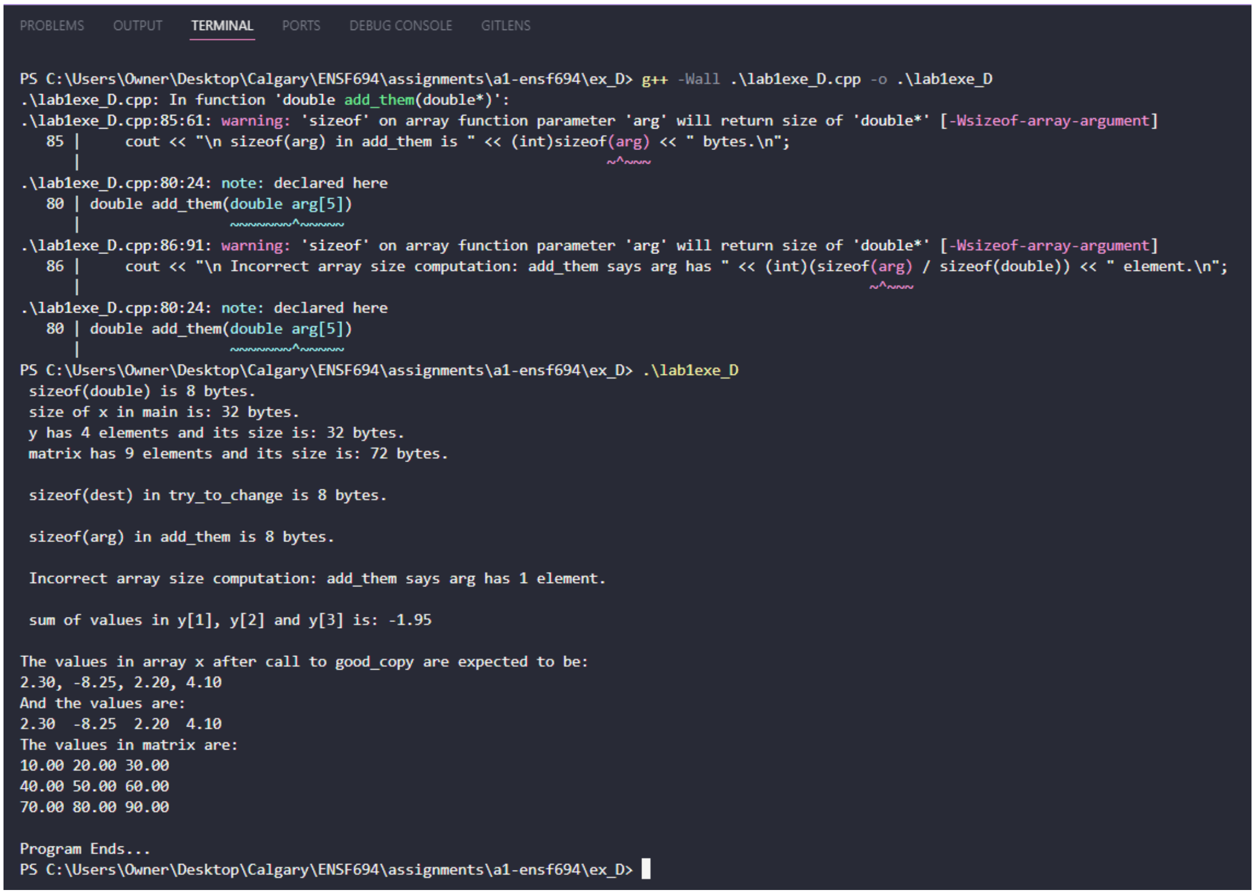


```
    sum = add_them(&y[1]);
    cout << "\n sum of values in y[1], y[2] and y[3] is: " << sum << endl;

    good_copy(x, y, 4);

    cout << "\nThe values in array x after call to good_copy are expected to be:";
    cout << "\n2.30, -8.25, 2.20, 4.10\n";
    cout << "And the values are:\n";
    for (int i = 0; i < 4; i++)
        cout << fixed << setprecision(2) << x[i] << "  ";

    cout << "\nThe values in matrix are:\n";
    print_matrix(matrix, 3);

    cout << "\nProgram Ends...\n";

    return 0;
}

void try_to_copy(double dest[], double source[])
{
    dest = source;

    /* point one*/

    return;
}

void try_to_change(double *dest)
{
    dest[3] = 49.0;

    /* point two*/
    cout << "\n sizeof(dest) in try_to_change is " << (int)sizeof(dest) << " bytes.\n";
    return;
}

```



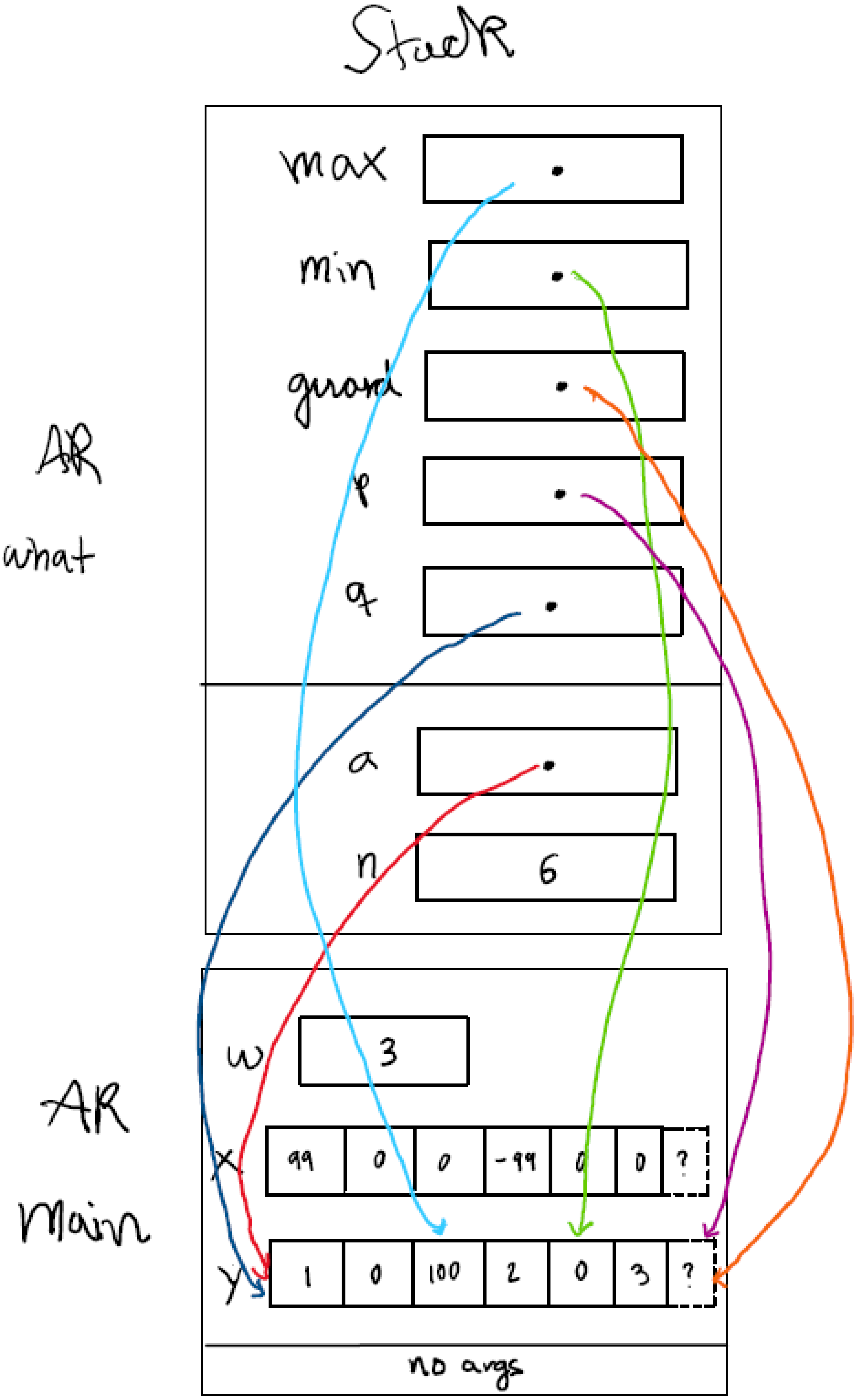
```cpp
double add_them(double arg[5])
{
    *arg = -8.25;

    /* point three */
    cout << "\n sizeof(arg) in add_them is " << (int)sizeof(arg) << " bytes.\n";
    cout << "\n Incorrect array size computation: add_them says arg has " << (int)(sizeof(arg) / sizeof(double)) << " element.\n";

    return arg[0] + arg[1] + arg[2];
}

void good_copy(double *dest, double *source, int n)
{
    for (int i = 0; i < n; i++)
    {
        dest[i] = source[i];
    }
}

void print_matrix(double matrix[][COL_SIZE], int rows)
{
    for (int i = 0; i < rows; i++)
    {
        for (int j = 0; j < COL_SIZE; j++)
        {
            // Print the element at the current row (i) and column (j) followed by a space
            cout << matrix[i][j] << " ";
        }
        // After printing current row, print a newline character
        cout << endl;
    }
}

```

Program Output



```
PS C:\Users\Owner\Desktop\Calgary\ENSF694\assignments\a1-ensf694\ex_D> g++ -Wall .\lab1exe_D.cpp -o .\lab1exe_D
.\lab1exe_D.cpp: In function 'double add_them(double*)':
.\lab1exe_D.cpp:85:61: warning: 'sizeof' on array function parameter 'arg' will return size of 'double*' [-Wsizeof-array-argument]
   85 |     cout << "\n sizeof(arg) in add_them is " << (int)sizeof(arg) << " bytes.\n";
      |                                                            ~^~~~
.\lab1exe_D.cpp:80:24: note: declared here
   80 | double add_them(double arg[5])
      |                 ~~~~~~~^~~~~
.\lab1exe_D.cpp:86:91: warning: 'sizeof' on array function parameter 'arg' will return size of 'double*' [-Wsizeof-array-argument]
   86 |     cout << "\n Incorrect array size computation: add_them says arg has " << (int)(sizeof(arg) / sizeof(double)) << " element.\n";
      |                                                                                          ~^~~~
.\lab1exe_D.cpp:80:24: note: declared here
   80 | double add_them(double arg[5])
      |                 ~~~~~~~^~~~~
PS C:\Users\Owner\Desktop\Calgary\ENSF694\assignments\a1-ensf694\ex_D> .\lab1exe_D
 sizeof(double) is 8 bytes.
 size of x in main is: 32 bytes.
 y has 4 elements and its size is: 32 bytes.
 matrix has 9 elements and its size is: 72 bytes.

 sizeof(dest) in try_to_change is 8 bytes.

 sizeof(arg) in add_them is 8 bytes.

 Incorrect array size computation: add_them says arg has 1 element.

 sum of values in y[1], y[2] and y[3] is: -1.95

The values in array x after call to good_copy are expected to be:
2.30, -8.25, 2.20, 4.10
And the values are:
2.30  -8.25  2.20  4.10
The values in matrix are:
10.00 20.00 30.00
40.00 50.00 60.00
70.00 80.00 90.00

Program Ends...
PS C:\Users\Owner\Desktop\Calgary\ENSF694\assignments\a1-ensf694\ex_D> 
```

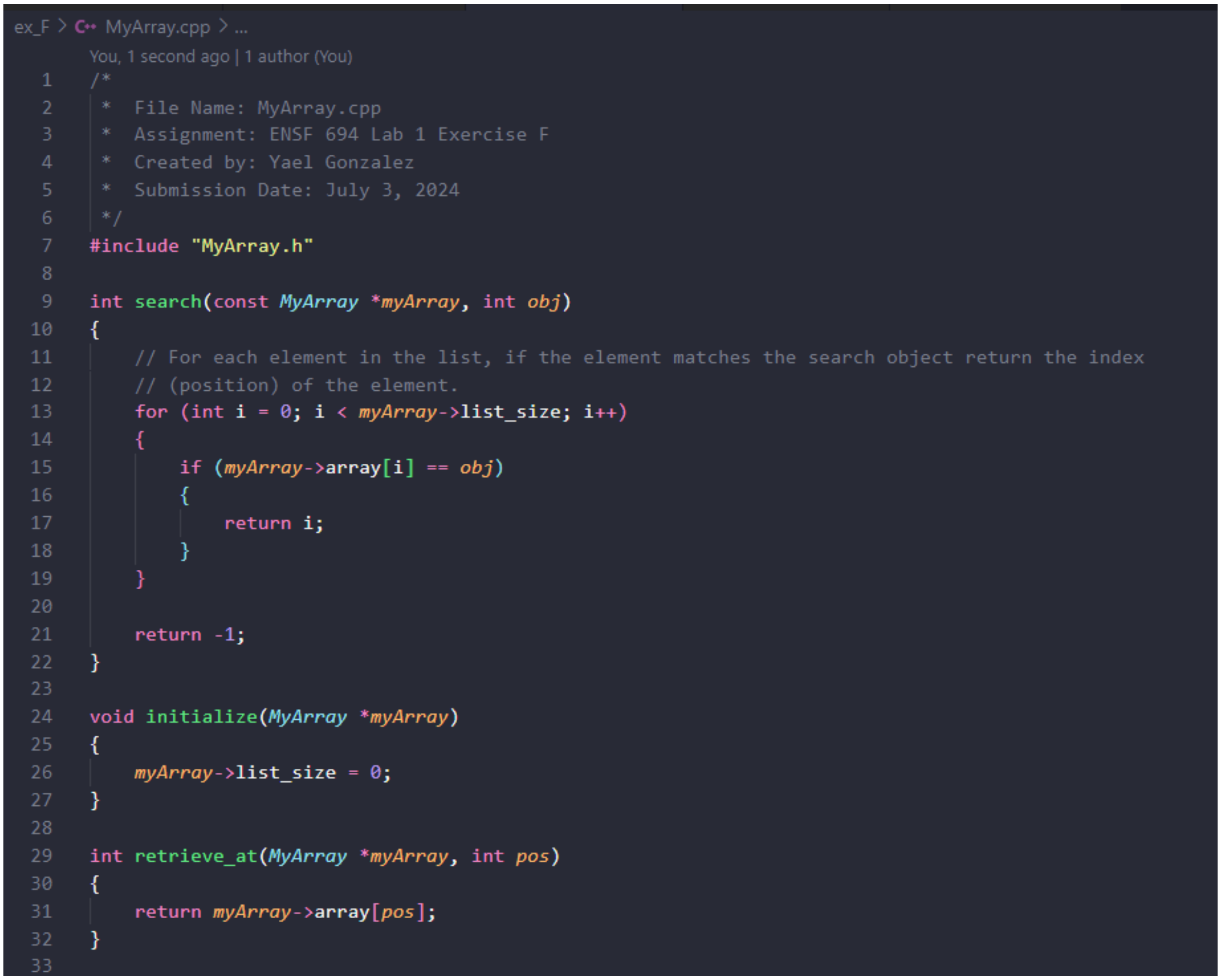
Exercise E


Stack
AR
what
max
min
guard
p
q
a
n
6
AR
main
w
3
x
99
0
0
-99
0
0
?
y
1
0
100
2
0
3
?
no args

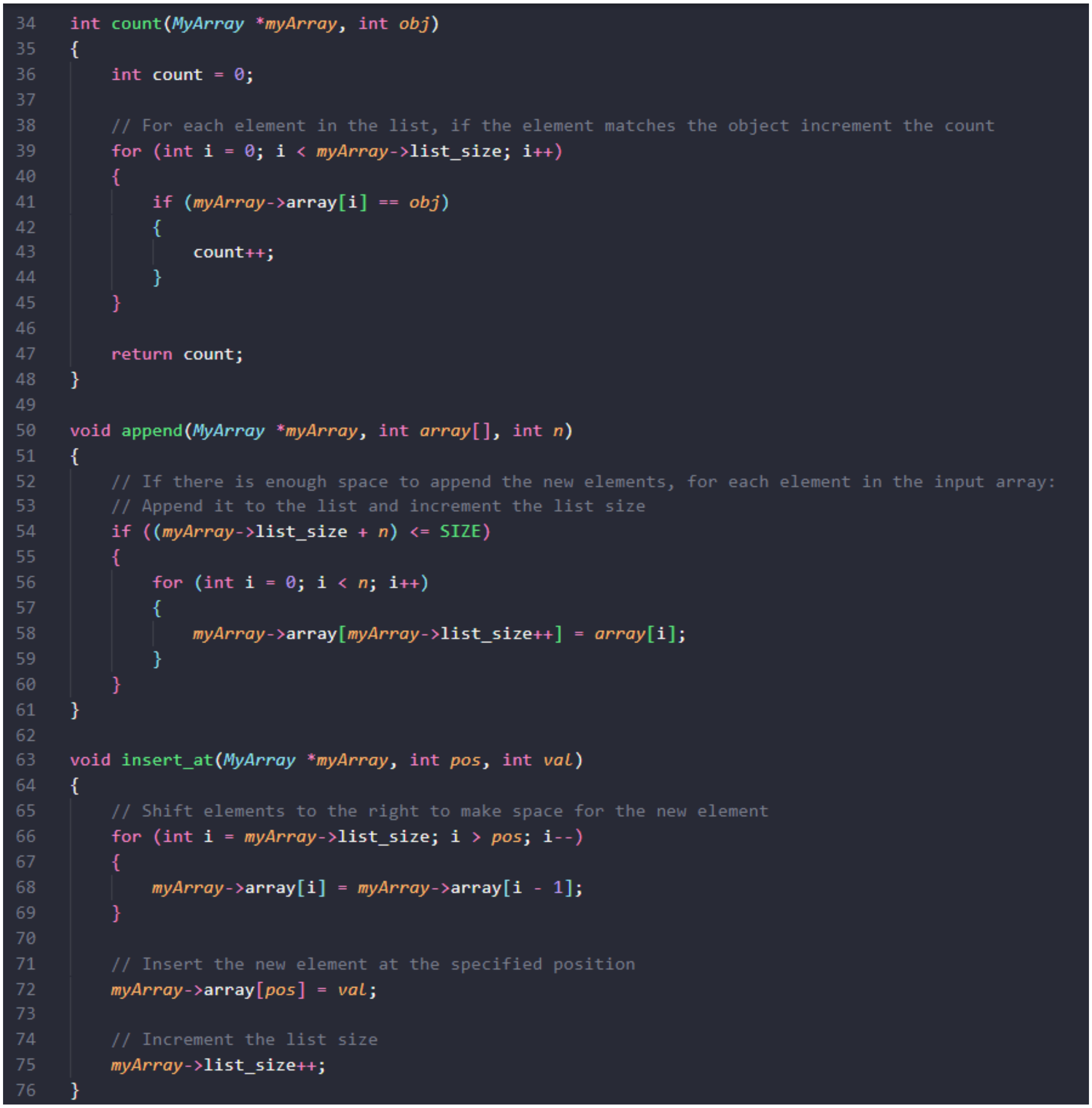
Exercise F

Note on how to submit: Copy and paste your source code, `MyArray.cpp`, and the program output into your lab report. Also upload your source code: `MyArray.h`, and `MyArray.cpp` into the Dropbox on the D2L.

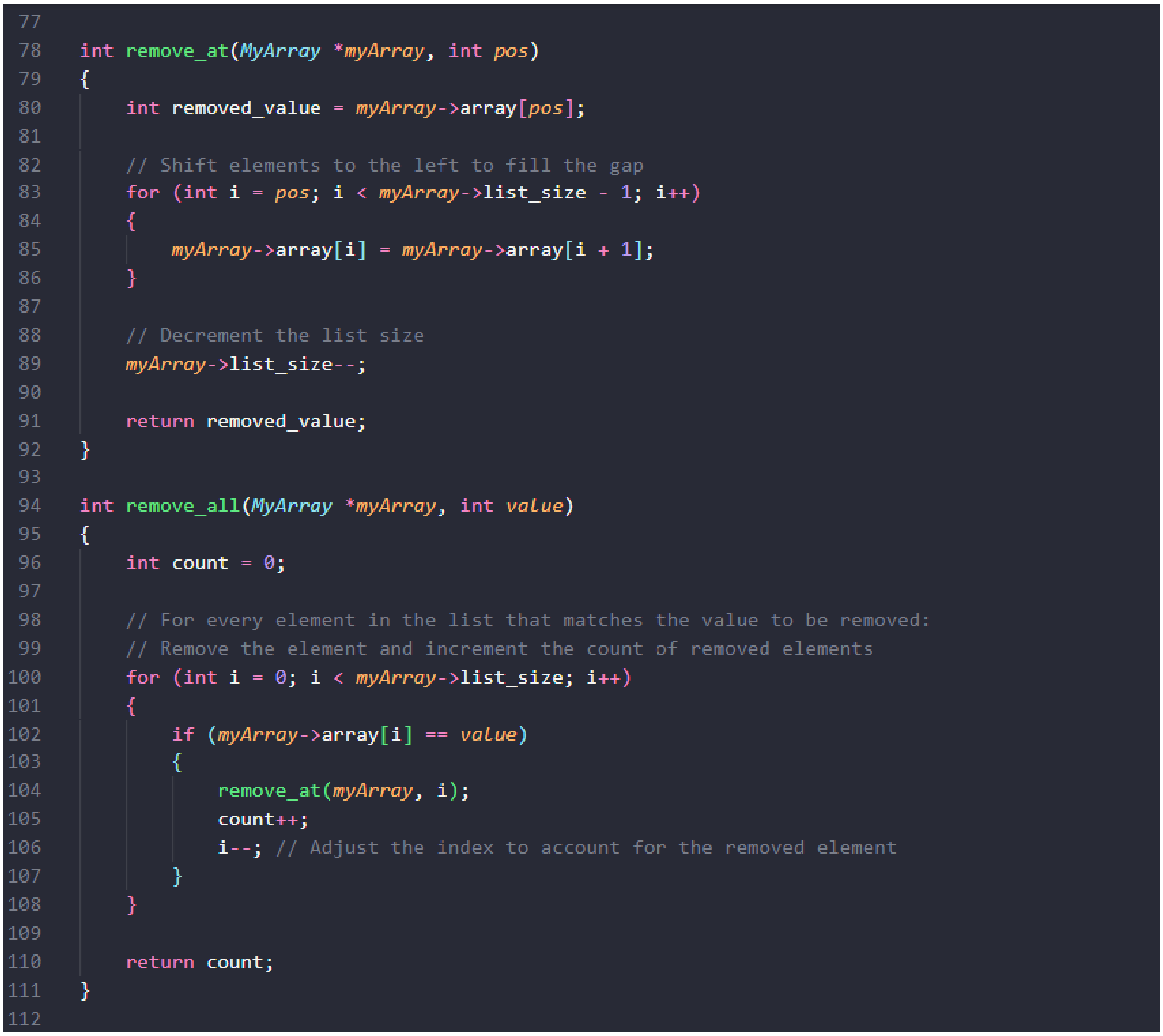
Source Code



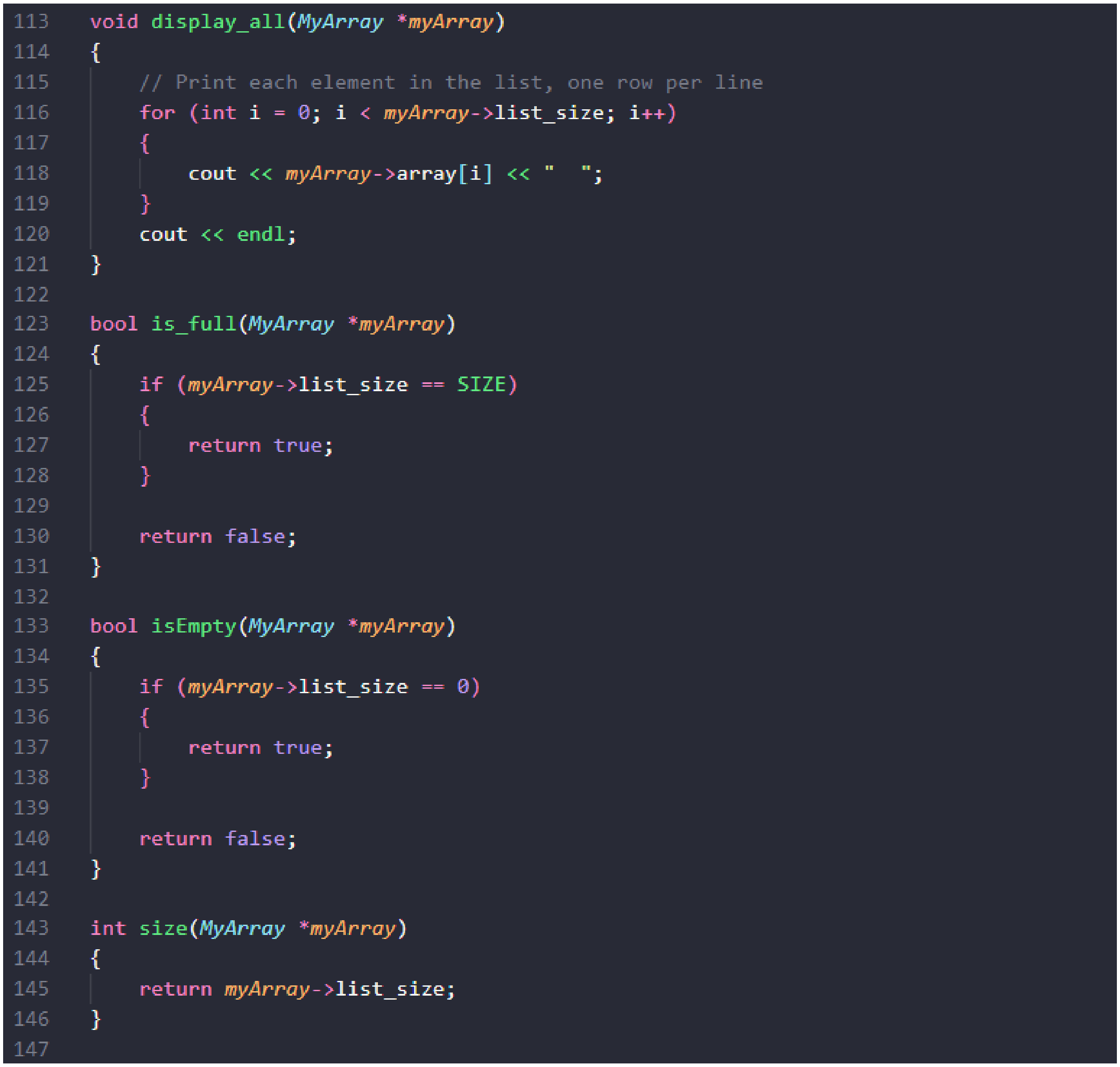
```cpp
/*
 *  File Name: MyArray.cpp
 *  Assignment: ENSF 694 Lab 1 Exercise F
 *  Created by: Yael Gonzalez
 *  Submission Date: July 3, 2024
 */
#include "MyArray.h"

int search(const MyArray *myArray, int obj)
{
    // For each element in the list, if the element matches the search object return the index
    // (position) of the element.
    for (int i = 0; i < myArray->list_size; i++)
    {
        if (myArray->array[i] == obj)
        {
            return i;
        }
    }

    return -1;
}

void initialize(MyArray *myArray)
{
    myArray->list_size = 0;
}

int retrieve_at(MyArray *myArray, int pos)
{
    return myArray->array[pos];
}

```



```c
int count(MyArray *myArray, int obj)
{
    int count = 0;

    // For each element in the list, if the element matches the object increment the count
    for (int i = 0; i < myArray->list_size; i++)
    {
        if (myArray->array[i] == obj)
        {
            count++;
        }
    }

    return count;
}

void append(MyArray *myArray, int array[], int n)
{
    // If there is enough space to append the new elements, for each element in the input array:
    // Append it to the list and increment the list size
    if ((myArray->list_size + n) <= SIZE)
    {
        for (int i = 0; i < n; i++)
        {
            myArray->array[myArray->list_size++] = array[i];
        }
    }
}

void insert_at(MyArray *myArray, int pos, int val)
{
    // Shift elements to the right to make space for the new element
    for (int i = myArray->list_size; i > pos; i--)
    {
        myArray->array[i] = myArray->array[i - 1];
    }

    // Insert the new element at the specified position
    myArray->array[pos] = val;

    // Increment the list size
    myArray->list_size++;
}
```

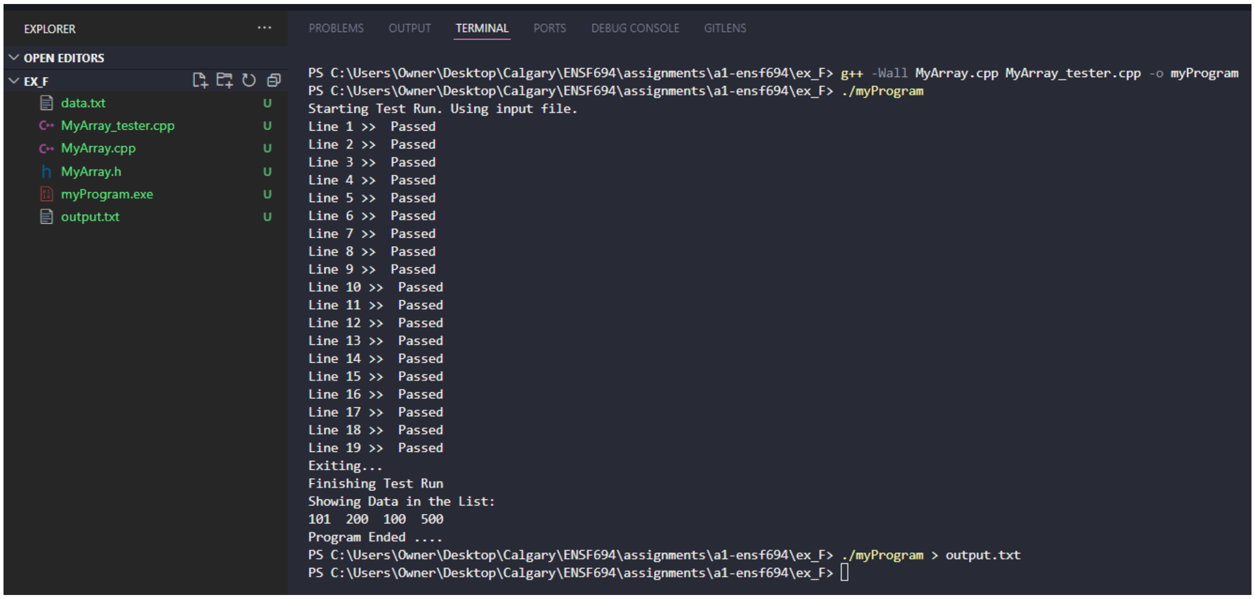


```c

int remove_at(MyArray *myArray, int pos)
{
    int removed_value = myArray->array[pos];

    // Shift elements to the left to fill the gap
    for (int i = pos; i < myArray->list_size - 1; i++)
    {
        myArray->array[i] = myArray->array[i + 1];
    }

    // Decrement the list size
    myArray->list_size--;

    return removed_value;
}

int remove_all(MyArray *myArray, int value)
{
    int count = 0;

    // For every element in the list that matches the value to be removed:
    // Remove the element and increment the count of removed elements
    for (int i = 0; i < myArray->list_size; i++)
    {
        if (myArray->array[i] == value)
        {
            remove_at(myArray, i);
            count++;
            i--; // Adjust the index to account for the removed element
        }
    }

    return count;
}

```



```
void display_all(MyArray *myArray)
{
    // Print each element in the list, one row per line
    for (int i = 0; i < myArray->list_size; i++)
    {
        cout << myArray->array[i] << "  ";
    }
    cout << endl;
}

bool is_full(MyArray *myArray)
{
    if (myArray->list_size == SIZE)
    {
        return true;
    }

    return false;
}

bool isEmpty(MyArray *myArray)
{
    if (myArray->list_size == 0)
    {
        return true;
    }

    return false;
}

int size(MyArray *myArray)
{
    return myArray->list_size;
}

```

Program Output



```
PS C:\Users\Owner\Desktop\Calgary\ENSF694\assignments\a1-ensf694\ex_F> g++ -Wall MyArray.cpp MyArray_tester.cpp -o myProgram
PS C:\Users\Owner\Desktop\Calgary\ENSF694\assignments\a1-ensf694\ex_F> ./myProgram
Starting Test Run. Using input file.
Line 1 >>  Passed
Line 2 >>  Passed
Line 3 >>  Passed
Line 4 >>  Passed
Line 5 >>  Passed
Line 6 >>  Passed
Line 7 >>  Passed
Line 8 >>  Passed
Line 9 >>  Passed
Line 10 >>  Passed
Line 11 >>  Passed
Line 12 >>  Passed
Line 13 >>  Passed
Line 14 >>  Passed
Line 15 >>  Passed
Line 16 >>  Passed
Line 17 >>  Passed
Line 18 >>  Passed
Line 19 >>  Passed
Exiting...
Finishing Test Run
Showing Data in the List:
101  200  100  500
Program Ended ....
PS C:\Users\Owner\Desktop\Calgary\ENSF694\assignments\a1-ensf694\ex_F> ./myProgram > output.txt
PS C:\Users\Owner\Desktop\Calgary\ENSF694\assignments\a1-ensf694\ex_F> 
```