Homework No. 2
Computing the Area of a Triangle

Objective

This second assignment requires the writing of a C++ program from “scratch” to solve a given problem. The problem involves the computation of the area of a triangle given the coordinates of its three vertices. We go through all the stages of the software development process ending with the testing of the code with a suitable test suite.

Problem Statement and Analysis

The problem involves the computation of a triangle’s area given the coordinates of its three vertices. The six values (two real values each for its three vertices) are given as input to the program and the area is computed using the appropriate formulas (see below).

Algorithm

The program is an instance of the classic input-process-output model. The following are obtained as input:

- x1 the x-coordinate of the first vertex
- y1 the y-coordinate of the first vertex
- x2 the x-coordinate of the second vertex
- y2 the y-coordinate of the second vertex
- x3 the x-coordinate of the third vertex
- y3 the y-coordinate of the third vertex

The area can be computed by using the following formulas:

\[
\begin{align*}
    a &= (x1*y2 - x2*y1) \\
    b &= (x2*y3 - x3*y2) \\
    c &= (x3*y1 - x1*y3) \\
    \text{area} &= -0.5*(a + b + c)
\end{align*}
\]

These formulas were supplied as part of the homework description. To summarize the algorithm, the program goes through the following steps:

1. Obtain the coordinates of the three vertices;
2. Compute the area of the triangle using the formulas given above; and
3. Display the results.
Program Implementation

The program is given below in text format. A screen capture of the compilation result is then supplied immediately after:

```cpp
#include <iostream>
#include <cmath>
using namespace std;

/* A program that accepts the coordinates of three vertices (six values * in all) that comprise a triangle, then computes the area of the * triangle whose vertices have these six values as their coordinates. *

* Program variables are:
*     x1 : x-coordinate of first vertex
*     y1 : y-coordinate of first vertex
*     x2 : x-coordinate of second vertex
*     y2 : y-coordinate of second vertex
*     x3 : x-coordinate of third vertex
*     y3 : y-coordinate of third vertex
*     a : intermediate result
*     b : intermediate result
*     c : intermediate result
*     area : area of triangle
*
* Input  : x1, y1, x2, y2, x3, y3
* Output : area
* Working : a, b, c
*/

int main() {

//declaration of variables
    double x1, y1, x2, y2, x3, y3, a, b, c, area;

//initialization of variables
    x1 = y1 = 0.0;
    x2 = y2 = 0.0;
    x3 = y3 = 0.0;
    a = b = c = 0.0;
    area = 0.0;

//prompt for and read in the six coordinate values
    cout << "Enter coordinates of first vertex (Example: 0.0 0.0): ";
    cin >> x1 >> y1;
    cout << "Enter coordinates of second vertex (Example: 0.0 0.0): ";
    cin >> x2 >> y2;
    cout << "Enter coordinates of third vertex (Example: 0.0 0.0): ";
    cin >> x3 >> y3;

//compute the area using the formulas
    a = ( x1*y2 - x2*y1 );
    b = ( x2*y3 - x3*y2 );
    c = ( x3*y1 - x1*y3 );
    area = -0.5*( a + b + c );

//display the result
    cout << "The area is: " << area << endl;
    system("PAUSE");
    return 0;
}
```

Screen capture of result of compilation using Dev-C++ showing no errors in the compilation:

Program Testing and Verification

The test suite and the results of the runs vis-a-vis the test suite are tabulated below. The input to the program runs are in columns 2 through 7. We calculated the expected value of the area and entered them in column 8. The actual results are tabulated in the last two columns.

<table>
<thead>
<tr>
<th>Run No.</th>
<th>$x_1$</th>
<th>$y_1$</th>
<th>$x_2$</th>
<th>$y_2$</th>
<th>$x_3$</th>
<th>$y_3$</th>
<th>Expected area</th>
<th>Actual value</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>1.0</td>
<td>1.0</td>
<td>0.0</td>
<td>0.5</td>
<td>0.5</td>
<td>As expected</td>
</tr>
<tr>
<td>2</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>−1.0</td>
<td>−1.0</td>
<td>0.0</td>
<td>0.5</td>
<td>0.5</td>
<td>As expected</td>
</tr>
<tr>
<td>3</td>
<td>1.0</td>
<td>0.0</td>
<td>0.0</td>
<td>1.0</td>
<td>0.0</td>
<td>0.0</td>
<td>−0.5</td>
<td>−0.5</td>
<td>As expected</td>
</tr>
<tr>
<td>4</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>10.0</td>
<td>10.0</td>
<td>0.0</td>
<td>50.0</td>
<td>50.0</td>
<td>As expected</td>
</tr>
<tr>
<td>5</td>
<td>0.0</td>
<td>0.0</td>
<td>2.0</td>
<td>2.0</td>
<td>4.0</td>
<td>0.0</td>
<td>4.0</td>
<td>4.0</td>
<td>As expected</td>
</tr>
<tr>
<td>6</td>
<td>−1.0</td>
<td>1.0</td>
<td>4.0</td>
<td>2.0</td>
<td>3.0</td>
<td>−1.0</td>
<td>7.0</td>
<td>7.0</td>
<td>As expected</td>
</tr>
<tr>
<td>7</td>
<td>0.0</td>
<td>0.0</td>
<td>1.0</td>
<td>0.0</td>
<td>2.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>As expected</td>
</tr>
</tbody>
</table>
The seven runs are documented in screen captures below:

**Run No. 1:**

```
C:\cppFiles\areaOfTriangle.exe
Enter coordinates of first vertex (Example: 0.0 0.0): 0.0 0.0
Enter coordinates of second vertex (Example: 0.0 0.0): 0.0 1.0
Enter coordinates of third vertex (Example: 0.0 0.0): 1.0 0.0
The area is: 0.5
Press any key to continue . . .
```

**Run No. 2:**

```
C:\cppFiles\areaOfTriangle.exe
Enter coordinates of first vertex (Example: 0.0 0.0): 0.0 0.0
Enter coordinates of second vertex (Example: 0.0 0.0): 0.0 -1.0
Enter coordinates of third vertex (Example: 0.0 0.0): -1.0 0.0
The area is: 0.5
Press any key to continue . . .
```

**Run No. 3:**

```
C:\cppFiles\areaOfTriangle.exe
Enter coordinates of first vertex (Example: 0.0 0.0): 1.0 0.0
Enter coordinates of second vertex (Example: 0.0 0.0): 0.0 1.0
Enter coordinates of third vertex (Example: 0.0 0.0): 0.0 0.0
The area is: -0.5
Press any key to continue . . .
```

**Run No. 4:**

```
C:\cppFiles\areaOfTriangle.exe
Enter coordinates of first vertex (Example: 0.0 0.0): 0.0 0.0
Enter coordinates of second vertex (Example: 0.0 0.0): 0.0 10.0
Enter coordinates of third vertex (Example: 0.0 0.0): 10.0 0.0
The area is: 50
Press any key to continue . . .
```
Run No. 5:

Enter coordinates of first vertex (Example: 0.0 0.0): 0.0 0.0
Enter coordinates of second vertex (Example: 0.0 0.0): 2.0 2.0
Enter coordinates of third vertex (Example: 0.0 0.0): 4.0 0.0
The area is: 4
Press any key to continue . . .

Run No. 6:

Enter coordinates of first vertex (Example: 0.0 0.0): -1.0 1.0
Enter coordinates of second vertex (Example: 0.0 0.0): 4.0 2.0
Enter coordinates of third vertex (Example: 0.0 0.0): 3.0 -1.0
The area is: ?
Press any key to continue . . .

Run No. 7:

Enter coordinates of first vertex (Example: 0.0 0.0): 0.0 0.0
Enter coordinates of second vertex (Example: 0.0 0.0): 1.0 0.0
Enter coordinates of third vertex (Example: 0.0 0.0): 2.0 0.0
The area is: 0
Press any key to continue . . .

Conclusion

In this assignment, we analyzed a problem, designed an algorithm built around the supplied formulas, implemented the algorithm in a C++ program, entered the code using a text editor, compiled it, got rid of the syntax errors, ran test data, adjusted the input/output dialogue, recompiled, ran test data, and repeated this cycle until further test runs indicated that the program was most probably correct according to its specification.

The results of the test runs are tabulated and compared with the expected outcome. All output was as expected.