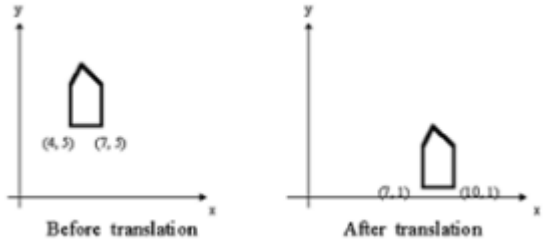
Experiment No 6

Title Implement following 2D transformations on the object with respect to axis : i) Scaling ii) Rotation about arbitrary point iii) Reflection

Translation: Translation is defined as moving the object from one position to

another position along

straight line path.



We can move the objects based on translation distances along x and y axis. tx denotes translation distance along x-axis and ty denotes translation distance along y axis.

Translation Distance: It is nothing but by how much units we should shift the object from one location to another along x, y-axis.

Consider (x,y) are old coordinates of a point. Then the new coordinates of that same point (x',y') can be obtained as follows:

X'=x+tx

Y'=y+ty

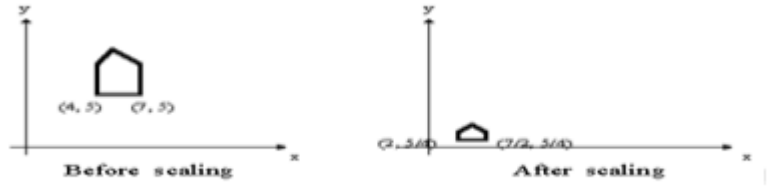
Scaling: scaling refers to changing the size of the object either by increasing or decreasing. We will increase or decrease the size of the object based on scaling factors along x and y - axis.

If (x, y) are old coordinates of object, then new coordinates of object after applying scaling transformation are obtained as:

x'=x*sx

y'=y*sy.

sx and sy are scaling factors along x-axis and y-axis. we express the above equations in matrix form as:



Rotation : A rotation repositions all points in an object along a circular path in the plane centered at the

pivot point. We rotate an object by an angle theta

New coordinates after rotation depend on both x and y

$x' = x\cos\theta - y\sin\theta$

$y' = x\sin\theta + y\cos\theta$

or in matrix form:

P' = R • P,

R-rotation matrix.

Formula: X = xcosA - ysinA

Y = xsinA + ycosA,

A is the angle of rotation.

The above formula will rotate the point around the origin.

To rotate around a different point, the formula:

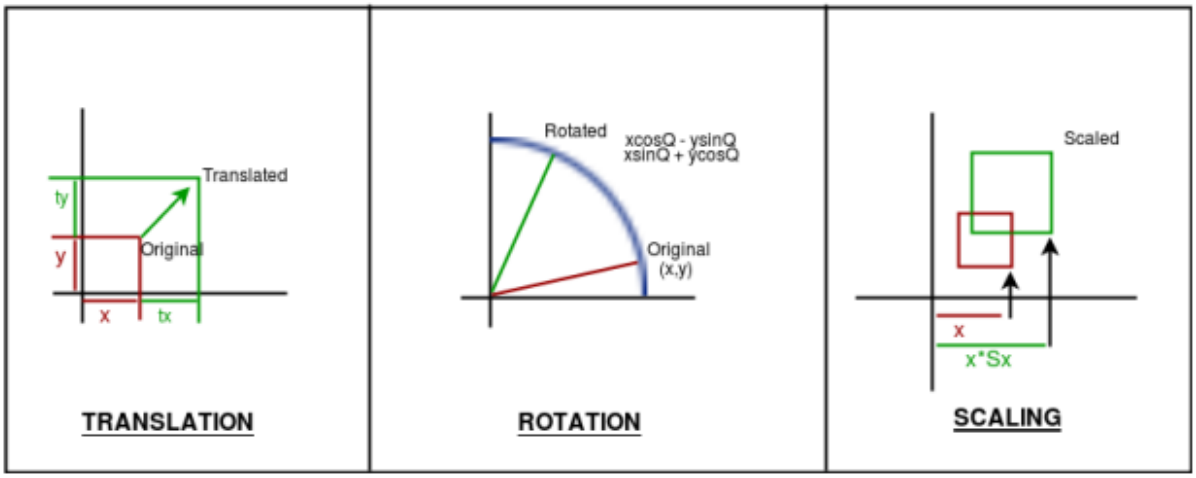
X = cx + (x-cx)*cosA - (y-cy)*sinA,

Y = cx + (x-cx)*sinA + (y-cy)*cosA,

cx, cy is centre coordinates,

A is the angle of rotation.

The OpenGL function is glRotatef (A, x, y, z).



Reflection: It is a transformation which produces a mirror image of an object. The mirror image can be either about x-axis or y-axis. The object is rotated by180°.

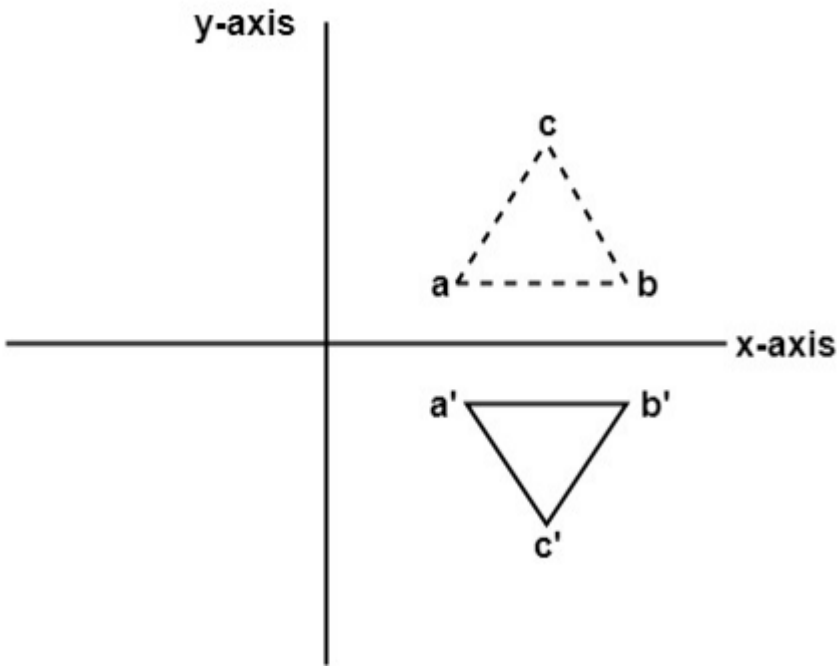
Types of Reflection:

1. Reflection about the x-axis
2. Reflection about the y-axis
3. Reflection about an axis perpendicular to xy plane and passing through the origin
4. Reflection about line y=x

1. Reflection about x-axis: The object can be reflected about x-axis with the help of the following matrix

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

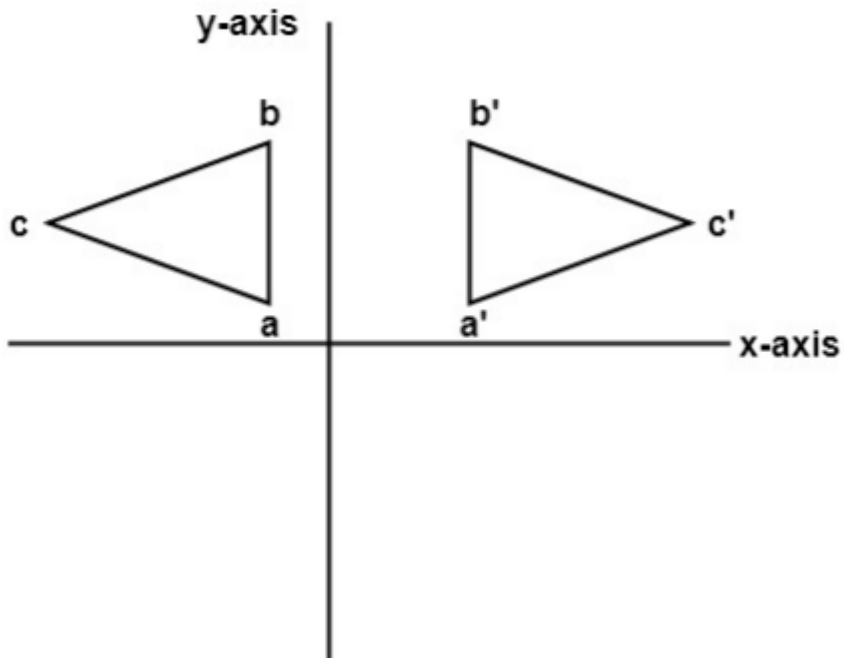
In this transformation value of x will remain same whereas the value of y will become negative. Following figures shows the reflection of the object axis. The object will lie another side of the x-axis.



2. Reflection about y-axis: The object can be reflected about y-axis with the help of following transformation matrix

Here the values of x will be reversed, whereas the value of y will remain the same. The object will lie another side of the y-axis.

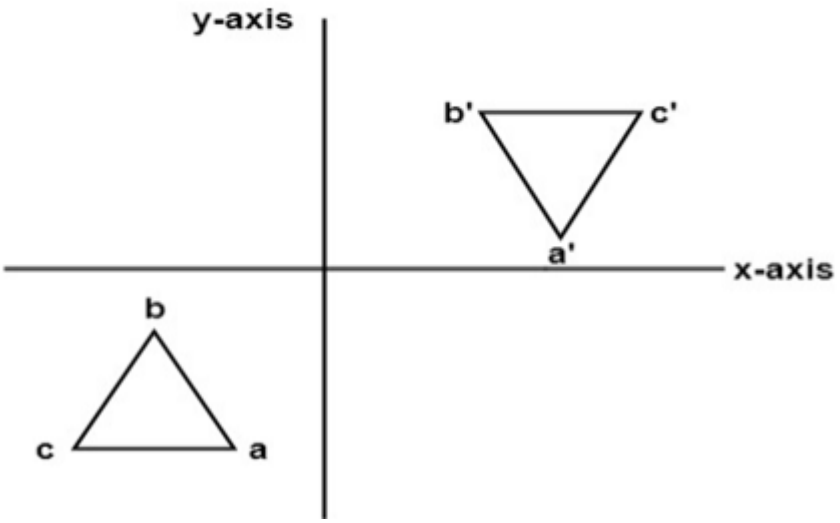
The following figure shows the reflection about the y-axis



3. Reflection about an axis perpendicular to xy plane and passing through origin:

In the matrix of this transformation is given below

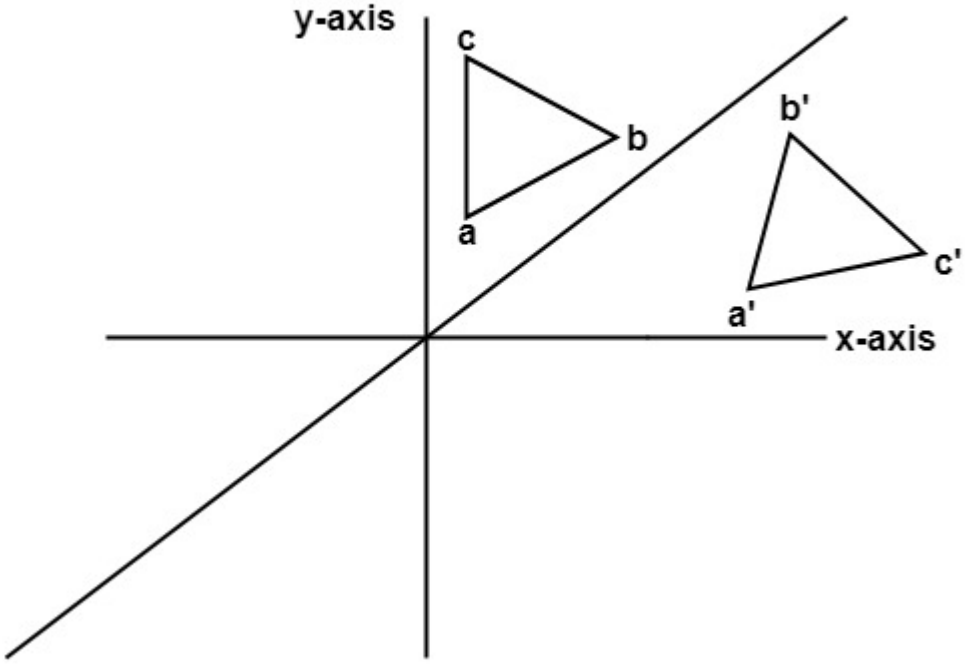
$$\begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$



In this value of x and y both will be reversed. This is also called as half revolution about the origin.

4. Reflection about line y=x: The object may be reflected about line y = x with the help of following transformation matrix

$$\begin{bmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$



First of all, the object is rotated at 45°. The direction of rotation is clockwise. After it

reflection is done concerning x-axis. The last step is the rotation of y=x back to its original position that is counterclockwise at 45°.

Example: A triangle ABC is given. The coordinates of A, B, C are given as

A (3 4)

B (6 4)

C (4 8)

Find reflected position of triangle i.e., to the x-axis

```
#include <iostream>
#include <math.h>
#include <time.h>
#include <GL/glut.h>
#include <vector>
using namespace std;
int edge;
vector<int> xpoint;
vector<int> ypoint;
int ch;
double round(double d){
 return floor(d + 0.5);
}
void init(){
 glClearColor(1.0,1.0,1.0,0.0);
 glMatrixMode(GL_PROJECTION);
 gluOrtho2D(0,640,0,480);
 glClear(GL_COLOR_BUFFER_BIT);
}
void translation(){
 int tx, ty;
 cout<<"\t Enter Tx, Ty \n";
 cin>> tx>> ty;
```

```
//Translate the point
for(int i=0;i<edge;i++){

xpoint[i] = xpoint[i] + tx;
ypoint[i] = ypoint[i] + ty;

}



glBegin(GL_POLYGON);
glColor3f(0,0,1);
for(int i=0;i<edge;i++){
glVertex2i(xpoint[i],ypoint[i]);
}
glEnd();
glFlush();
}
void rotaion(){
int cx, cy;
cout<<"\n Enter Ar point x , y ";
cin >> cx >> cy;

cx = cx+320;
cy = cy+240;
glColor3f(0.0, 1.0, 0.0);
glBegin(GL_POINTS);
glVertex2i(cx,cy);
glEnd();
glFlush();
```

```
 double the;
 cout<<"\n Enter thetha ";
 cin>>the;
 the = the * 3.14/180;

 glColor3f(0,0,1.0);
 glBegin(GL_POLYGON);
 for(int i=0;i<edge;i++){
 glVertex2i(round(((xpoint[i] - cx)*cos(the) - ((ypoint[i]-cy)*sin(the))) + cx),
 round(((xpoint[i] - cx)*sin(the) + ((ypoint[i]-cy)*cos(the))) + cy));
 }
 glEnd();
 glFlush();
}
void scale(){
 glColor3f(1.0,0,0);
 glBegin(GL_POLYGON);
 for(int i=0;i<edge;i++){
 glVertex2i(xpoint[i]-320,ypoint[i]-240);
 }
 glEnd();
 glFlush();
 cout<<"\n\tIn Scaling whole screen is 1st Qudrant \n";
 int sx, sy;
 cout<<"\t Enter sx, sy \n";
 cin>> sx>> sy;

 //scale the point
 for(int i=0;i<edge;i++){

 xpoint[i] = (xpoint[i]-320) * sx;
```

```
 ypoint[i] = (ypoint[i]-240) * sy;
 }

 glColor3f(0,0,1.0);
 glBegin(GL_POLYGON);
 for(int i=0;i<edge;i++){
 glVertex2i(xpoint[i],ypoint[i]);
 }
 glEnd();
 glFlush();
}
void reflection(){
 char reflection;
 cout<<"Enter Reflection Axis \n";
 cin>> reflection;

 if(reflection == 'x' || reflection == 'X'){

 glColor3f(0.0,0.0,1.0);
 glBegin(GL_POLYGON);
 for(int i=0;i<edge;i++){
 glVertex2i(xpoint[i], (ypoint[i] * -1)+480);
 }
 glEnd();
 glFlush();

 }
 else if(reflection == 'y' || reflection == 'Y'){
 glColor3f(0.0,0.0,1.0);
 glBegin(GL_POLYGON);
 for(int i=0;i<edge;i++){
```

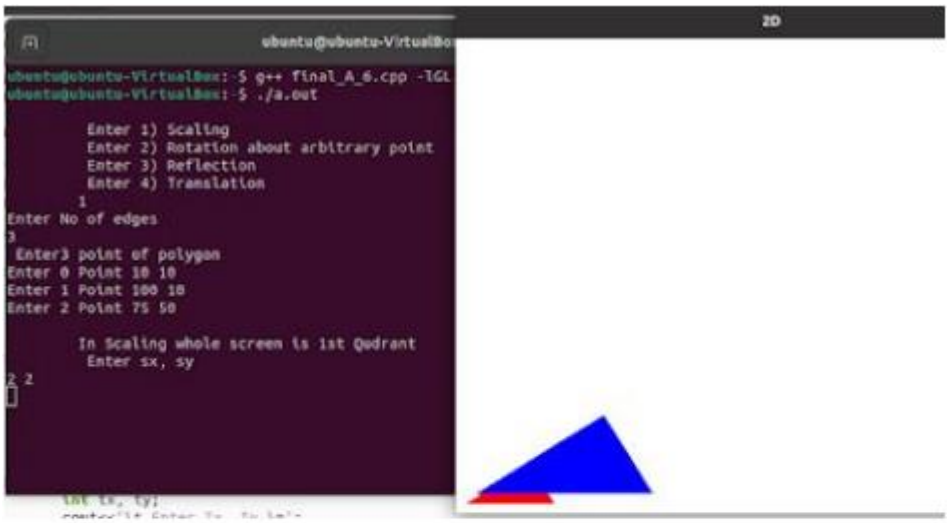
```
 glVertex2i((xpoint[i] * -1)+640,(ypoint[i]));
 }
 glEnd();
 glFlush();
 }
}
void Draw(){
 if(ch==2 || ch==3 || ch==4){
 glColor3f(1.0,0,0);
 glBegin(GL_LINES);
 glVertex2i(0,240);
 glVertex2i(640,240);
 glEnd();
 glColor3f(1.0,0,0);
 glBegin(GL_LINES);
 glVertex2i(320,0);
 glVertex2i(320,480);
 glEnd();
 glFlush();

 glColor3f(1.0,0,0);
 glBegin(GL_POLYGON);
 for(int i=0;i<edge;i++){
 glVertex2i(xpoint[i],ypoint[i]);
 }
 glEnd();
 glFlush();
 }
 if(ch==1){
 scale();
 }
```

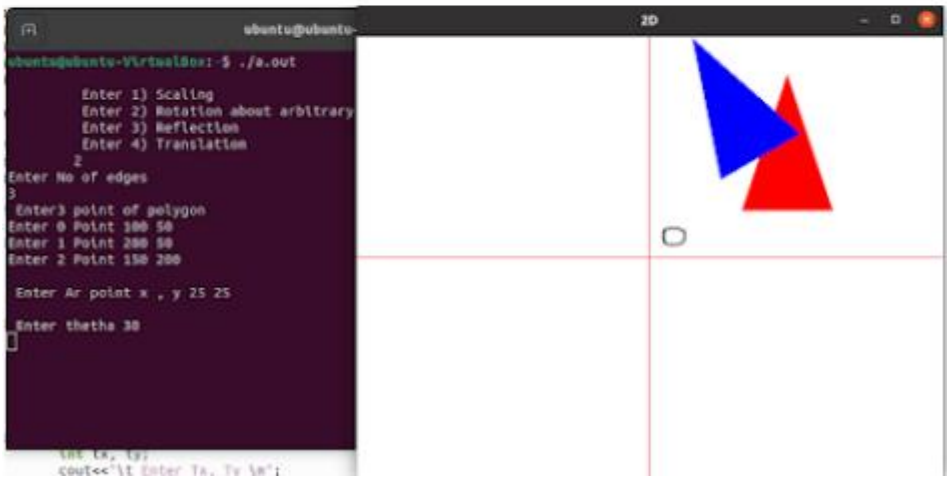
```
 else if(ch == 2){
 rotaion();
 }
 else if( ch == 3){
 reflection();
 }
 else if (ch == 4){
 translation();
 }
}
int main(int argc, char** argv){

 cout<<"\n \t Enter 1) Scaling ";
 cout<<"\n \t Enter 2) Rotation about arbitrary point";
 cout<<"\n \t Enter 3) Reflection";
 cout<<"\n \t Enter 4) Translation \n \t";

 cin>>ch;

 if(ch==1 || ch==2 || ch==3 || ch==4){

 cout<<"Enter No of edges \n";
 cin>> edge;
 int xpointnew, ypointnew;
 cout<<" Enter"<< edge <<" point of polygon \n";
 for(int i=0;i<edge;i++){

 cout<<"Enter "<< i << " Point ";
 cin>>xpointnew>>ypointnew;

 xpoint.push_back(xpointnew+320);
```

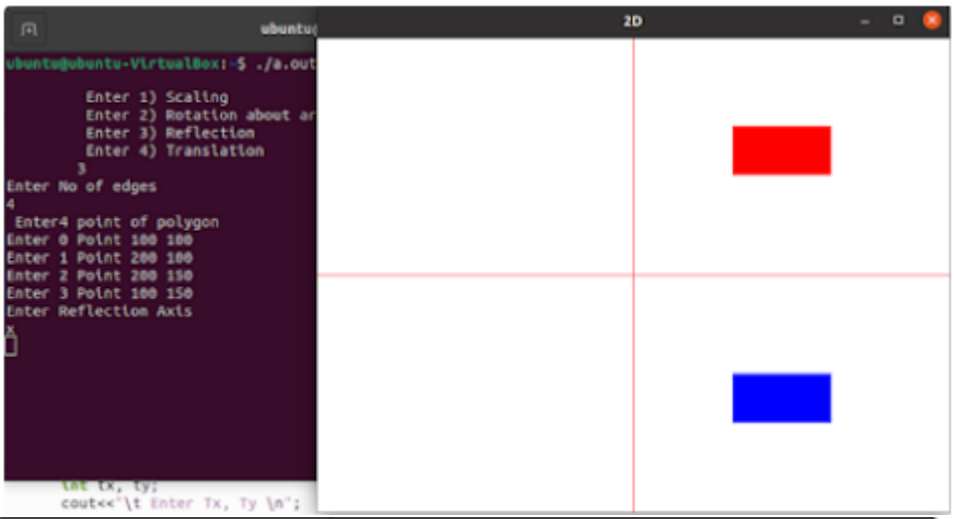
```
ypoint.push_back(ypointnew+240);


}
glutInit(&argc, argv);
glutInitDisplayMode(GLUT_SINGLE|GLUT_RGB);
glutInitWindowSize(640,480);
glutInitWindowPosition(200,200);
glutCreateWindow("2D");
init();
glutDisplayFunc(Draw);


glutMainLoop();
return 0;
}
else{
cout<<"\n \t Check Input run again";
return 0;
}
}
```

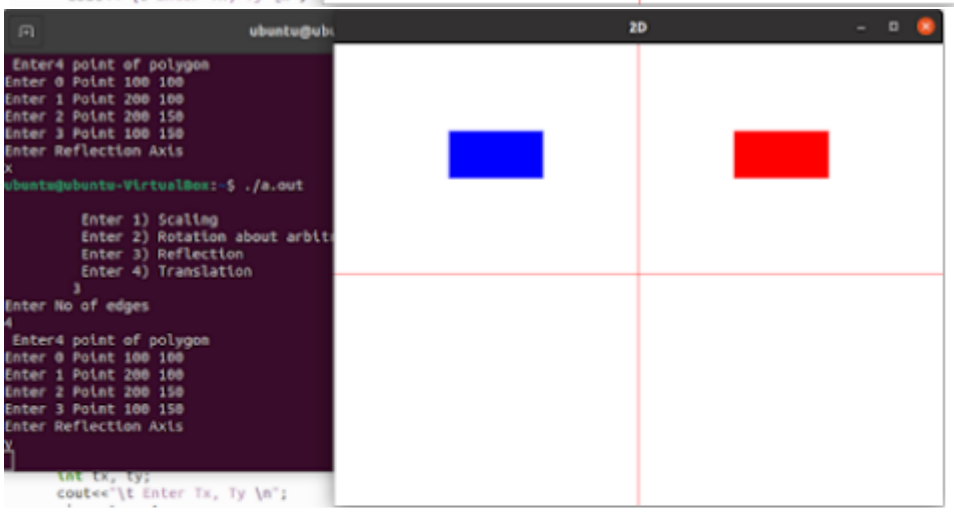
OUTPUT

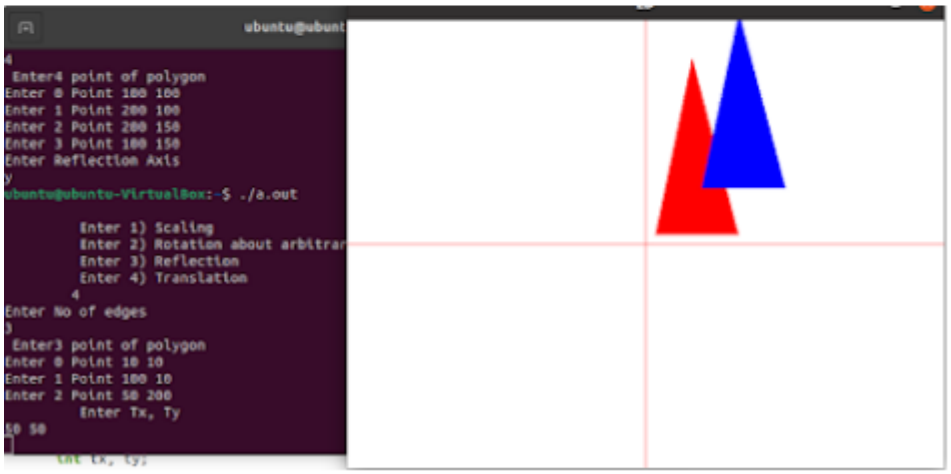
```
g++ filename.cpp -lGL -lGLU -lglut
./a.out
```


2D
ubuntu@ubuntu-VirtualBox:~$ g++ final_A_6.cpp -lGL
ubuntu@ubuntu-VirtualBox:~$ ./a.out
Enter 1) Scaling
Enter 2) Rotation about arbitrary point
Enter 3) Reflection
Enter 4) Translation
1
Enter No of edges
3
Enter3 point of polygon
Enter 0 Point 10 10
Enter 1 Point 100 10
Enter 2 Point 75 50
In Scaling whole screen is 1st Qudrant
Enter sx, sy
2 2


2D
ubuntu@ubuntu-VirtualBox:~$ ./a.out
Enter 1) Scaling
Enter 2) Rotation about arbitrary
Enter 3) Reflection
Enter 4) Translation
2
Enter No of edges
3
Enter3 point of polygon
Enter 0 Point 100 50
Enter 1 Point 200 50
Enter 2 Point 150 200
Enter Ar point x , y 25 25
Enter thetha 30


2D
ubuntu@ubuntu-VirtualBox:~$ ./a.out
Enter 1) Scaling
Enter 2) Rotation about ar
Enter 3) Reflection
Enter 4) Translation
Enter No of edges
4
Enter4 point of polygon
Enter 0 Point 100 100
Enter 1 Point 200 100
Enter 2 Point 200 150
Enter 3 Point 100 150
Enter Reflection Axis
x
int tx, ty;
cout<<"\t Enter Tx, Ty \n";


2D
Enter4 point of polygon
Enter 0 Point 100 100
Enter 1 Point 200 100
Enter 2 Point 200 150
Enter 3 Point 100 150
Enter Reflection Axis
x
ubuntu@ubuntu-VirtualBox:~$ ./a.out
Enter 1) Scaling
Enter 2) Rotation about arbit
Enter 3) Reflection
Enter 4) Translation
Enter No of edges
4
Enter4 point of polygon
Enter 0 Point 100 100
Enter 1 Point 200 100
Enter 2 Point 200 150
Enter 3 Point 100 150
Enter Reflection Axis
y
int tx, ty;
cout<<"\t Enter Tx, Ty \n";


4
Enter4 point of polygon
Enter 0 Point 100 100
Enter 1 Point 200 100
Enter 2 Point 200 150
Enter 3 Point 100 150
Enter Reflection Axis
y
ubuntu@ubuntu-VirtualBox:~$ ./a.out
Enter 1) Scaling
Enter 2) Rotation about arbitrar
Enter 3) Reflection
Enter 4) Translation
4
Enter No of edges
3
Enter3 point of polygon
Enter 0 Point 10 10
Enter 1 Point 100 10
Enter 2 Point 50 200
Enter Tx, Ty
50 50
int tx, ty;