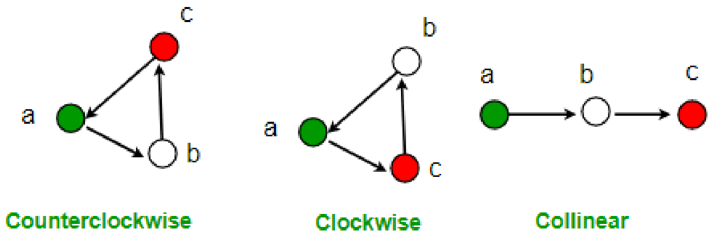
Orientation of 3 ordered points

Orientation of an ordered triplet of points in the plane can be

- counterclockwise
- clockwise
- colinear

The following diagram shows different possible orientations of (a,b,c)



If orientation of (p1, p2, p3) is collinear, then orientation of (p3, p2, p1) is also collinear.
If orientation of (p1, p2, p3) is clockwise, then orientation of (p3, p2, p1) is counterclockwise and vice versa is also true.

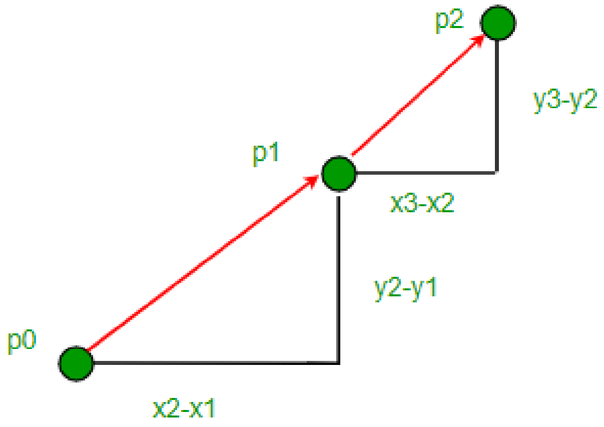
Given three points p1, p2 and p3, find orientation of (p1, p2, p3).
Example:

```
Input:   p1 = {0, 0}, p2 = {4, 4}, p3 = {1, 2}
Output:  CounterClockWise

Input:   p1 = {0, 0}, p2 = {4, 4}, p3 = {1, 1}
Output:  Colinear
```

How to compute Orientation?

```
The idea is to use slope.
```



```
Slope of line segment (p1, p2): σ = (y2 - y1)/(x2 - x1)
Slope of line segment (p2, p3): τ = (y3 - y2)/(x3 - x2)

If  σ < τ, the orientation is counterclockwise (left turn)
If  σ = τ, the orientation is collinear
If  σ > τ, the orientation is clockwise (right turn)

Using above values of σ and τ, we can conclude that,
the orientation depends on sign of  below expression:

(y2 - y1)*(x3 - x2) - (y3 - y2)*(x2 - x1)

Above expression is negative when σ < τ, i.e., counterclockwise
Above expression is 0 when σ = τ, i.e., collinear
Above expression is positive when σ > τ, i.e., clockwise
```

Below is the implementation of above idea.

C++

```
// A C++ program to find orientation of three points
#include <iostream>
using namespace std;

struct Point
{
    int x, y;
};

// To find orientation of ordered triplet (p1, p2, p3).
// The function returns following values
// 0 --> p, q and r are colinear
// 1 --> Clockwise
// 2 --> Counterclockwise
int orientation(Point p1, Point p2, Point p3)
{
    // See 10th slides from following link for derivation
    // of the formula
    int val = (p2.y - p1.y) * (p3.x - p2.x) -
              (p2.x - p1.x) * (p3.y - p2.y);

    if (val == 0) return 0;  // colinear

    return (val > 0)? 1: 2; // clock or counterclock wise
}

// Driver program to test above functions
int main()
{
    Point p1 = {0, 0}, p2 = {4, 4}, p3 = {1, 2};
    int o = orientation(p1, p2, p3);
    if (o==0)         cout << "Linear";
    else if (o == 1)  cout << "Clockwise";
    else              cout << "CounterClockwise";
    return 0;
}
```

Java

```
// JAVA Code to find Orientation of 3
// ordered points
class Point
{
    int x, y;
    Point(int x,int y){
        this.x=x;
        this.y=y;
    }
}

class GFG {

    // To find orientation of ordered triplet
    // (p1, p2, p3). The function returns
    // following values
    // 0 --> p, q and r are colinear
    // 1 --> Clockwise
    // 2 --> Counterclockwise
    public static int orientation(Point p1, Point p2,
                                         Point p3)
    {
        // See 10th slides from following link
        // for derivation of the formula
        int val = (p2.y - p1.y) * (p3.x - p2.x) -
                  (p2.x - p1.x) * (p3.y - p2.y);

        if (val == 0) return 0;  // colinear

        // clock or counterclock wise
        return (val > 0)? 1: 2;
    }

    /* Driver program to test above function */
    public static void main(String[] args)
    {
            Point p1 = new Point(0, 0);
            Point p2 = new Point(4, 4);
            Point p3 = new Point(1, 2);

            int o = orientation(p1, p2, p3);

            if (o==0)
            System.out.print("Linear");
            else if (o == 1)
            System.out.print("Clockwise");
            else
            System.out.print("CounterClockwise");

    }
}

//This code is contributed by Arnav Kr. Mandal.
```

Output:

```
CounterClockwise
```

The concept of orientation is used in below articles:

Find Simple Closed Path for a given set of points

How to check if two given line segments intersect?

Convex Hull | Set 1 (Jarvis's Algorithm or Wrapping)

Convex Hull | Set 2 (Graham Scan)

Source:

http://www.dcs.gla.ac.uk/~pat/52233/slides/Geometry1x1.pdf

This article is contributed by **Rajeev Agrawal**. Please write comments if you find anything incorrect, or you want to share more information about the topic discussed above

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