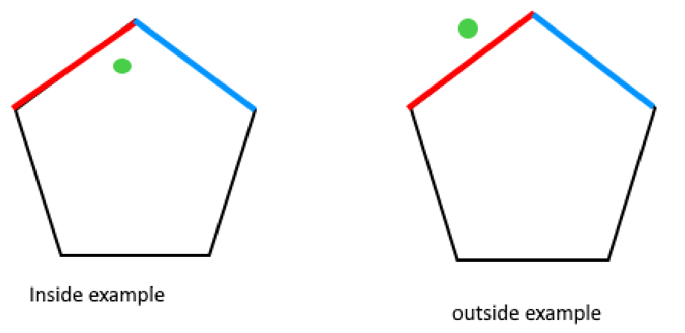
## How to check if a given point lies inside or outside a polygon?

Given a polygon and a point ‘p’, find if ‘p’ lies inside the polygon or not. The points lying on the border are considered inside.



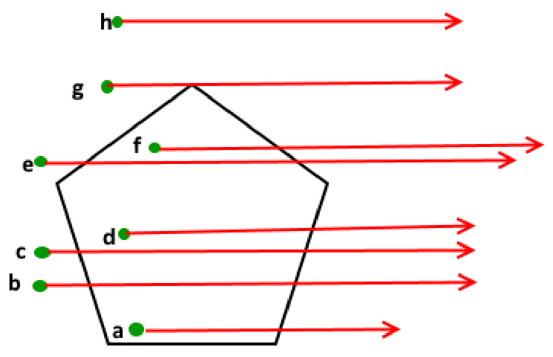
We strongly recommend to see the following post first.
How to check if two given line segments intersect?

Following is a simple idea to check whether a point is inside or outside.

**1)** Draw a horizontal line to the right of each point and extend it to infinity

**1)** Count the number of times the line intersects with polygon edges.

**2)** A point is inside the polygon if either count of intersections is odd or
point lies on an edge of polygon. If none of the conditions is true, then
point lies outside.



**How to handle point ‘g’ in the above figure?**

Note that we should returns true if the point lies on the line or same as one of the vertices of the given polygon. To handle this, after checking if the line from ‘p’ to extreme intersects, we check whether ‘p’ is colinear with vertices of current line of polygon. If it is coliear, then we check if the point ‘p’ lies on current side of polygon, if it lies, we return true, else false.

Following is C++ implementation of the above idea.

```
// A C++ program to check if a given point lies inside a given polygon
// Refer https://www.geeksforgeeks.org/check-if-two-given-line-segments-intersect/
// Refer https://www.geeksforgeeks.org/check-if-two-given-line-segments-intersect/
// for explanation of functions onSegment(), orientation() and doIntersect()
#include <iostream>
using namespace std;

// Define Infinite (Using INT_MAX caused overflow problems)
#define INF 10000

struct Point
{
    int x;
    int y;
};

// Given three colinear points p, q, r, the function checks if
// point q lies on line segment 'pr'
bool onSegment(Point p, Point q, Point r)
{
    if (q.x <= max(p.x, r.x) && q.x >= min(p.x, r.x) &&
            q.y <= max(p.y, r.y) && q.y >= min(p.y, r.y))
        return true;
    return false;
}

// To find orientation of ordered triplet (p, q, r).
// The function returns following values
// 0 --> p, q and r are colinear
// 1 --> Clockwise
// 2 --> Counterclockwise
int orientation(Point p, Point q, Point r)
{
    int val = (q.y - p.y) * (r.x - q.x) -
              (q.x - p.x) * (r.y - q.y);

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

// The function that returns true if line segment 'p1q1'
// and 'p2q2' intersect.
bool doIntersect(Point p1, Point q1, Point p2, Point q2)
{
    // Find the four orientations needed for general and
    // special cases
    int o1 = orientation(p1, q1, p2);
    int o2 = orientation(p1, q1, q2);
    int o3 = orientation(p2, q2, p1);
    int o4 = orientation(p2, q2, q1);

    // General case
    if (o1 != o2 && o3 != o4)
        return true;

    // Special Cases
    // p1, q1 and p2 are colinear and p2 lies on segment p1q1
    if (o1 == 0 && onSegment(p1, p2, q1)) return true;

    // p1, q1 and p2 are colinear and q2 lies on segment p1q1
    if (o2 == 0 && onSegment(p1, q2, q1)) return true;

    // p2, q2 and p1 are colinear and p1 lies on segment p2q2
    if (o3 == 0 && onSegment(p2, p1, q2)) return true;

     // p2, q2 and q1 are colinear and q1 lies on segment p2q2
    if (o4 == 0 && onSegment(p2, q1, q2)) return true;

    return false; // Doesn't fall in any of the above cases
}

// Returns true if the point p lies inside the polygon[] with n vertices
bool isInside(Point polygon[], int n, Point p)
{
    // There must be at least 3 vertices in polygon[]
    if (n < 3)  return false;

    // Create a point for line segment from p to infinite
    Point extreme = {INF, p.y};

    // Count intersections of the above line with sides of polygon
    int count = 0, i = 0;
    do
    {
        int next = (i+1)%n;

        // Check if the line segment from 'p' to 'extreme' intersects
        // with the line segment from 'polygon[i]' to 'polygon[next]'
        if (doIntersect(polygon[i], polygon[next], p, extreme))
        {
            // If the point 'p' is colinear with line segment 'i-next',
            // then check if it lies on segment. If it lies, return true,
            // otherwise false
            if (orientation(polygon[i], p, polygon[next]) == 0)
               return onSegment(polygon[i], p, polygon[next]);

            count++;
        }
        i = next;
    } while (i != 0);
    // Return true if count is odd, false otherwise
    return count&1;  // Same as (count%2 == 1)
}

// Driver program to test above functions
int main()
{
    Point polygon1[] = {{0, 0}, {10, 0}, {10, 10}, {0, 10}};
    int n = sizeof(polygon1)/sizeof(polygon1[0]);
    Point p = {20, 20};
    isInside(polygon1, n, p)? cout << "Yes \n": cout << "No \n";

    p = {5, 5};
    isInside(polygon1, n, p)? cout << "Yes \n": cout << "No \n";

    Point polygon2[] = {{0, 0}, {5, 5}, {5, 0}};
    p = {3, 3};
    n = sizeof(polygon2)/sizeof(polygon2[0]);
    isInside(polygon2, n, p)? cout << "Yes \n": cout << "No \n";

    p = {5, 1};
    isInside(polygon2, n, p)? cout << "Yes \n": cout << "No \n";

    p = {8, 1};
    isInside(polygon2, n, p)? cout << "Yes \n": cout << "No \n";

    Point polygon3[] =  {{0, 0}, {10, 0}, {10, 10}, {0, 10}};
    p = {-1,10};
    n = sizeof(polygon3)/sizeof(polygon3[0]);
    isInside(polygon3, n, p)? cout << "Yes \n": cout << "No \n";

    return 0;
}
```

Run on IDE

Output:

```
No
Yes
Yes
Yes
No
No
```

**Time Complexity:** O(n) where n is the number of vertices in the given polygon.

**Source:**

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

Please write comments if you find anything incorrect, or you want to share more information about the topic discussed above

**Practice Similar Questions On:** Mathematical Geometric

Geometric Mathematical geometric algorithms

Login to Improve this Article

## Recommended Posts:

How to check if two given line segments intersect?
Convex Hull | Set 1 (Jarvis’s Algorithm or Wrapping)
Find if two rectangles overlap
Check whether a given point lies inside a triangle or not
Given n line segments, find if any two segments intersect
Centered nonadecagonal number
Centered Octadecagonal Number
Hendecagonal number
Icosagonal number
Centered decagonal number

<< Previous Post

Next Post >>

(Login to Rate)

3.9 Average Difficulty : **3.9/5.0**
Based on **26** vote(s)

Basic Easy Medium Hard Expert

🟩 Add to TODO List

🟩 Mark as DONE

Writing code in comment? Please use ide.geeksforgeeks.org, generate link and share the link here.

Load Comments

Share this post!

## Trending Content

Python List , Set , Tuple & Dictionary

Number Theory

Set to Array in Java

BFS , DFS

School Programming

Longest Repeated Subsequence

Longest Palindromic Subsequence

Detect a negative cycle.

GATE CS Notes

Reverse a linked list

## Most Visited Posts

Top 10 Algorithms and Data Structures for Competitive Programming

Top 10 algorithms in Interview Questions

How to begin with Competitive Programming?

Step by Step Guide for Placement Preparation

How to prepare for ACM-ICPC?

Insertion Sort , Binary Search , QuickSort , MergeSort , HeapSort

## Popular Categories

Interview Experiences

Advanced Data Structures

Dynamic Programming

Greedy Algorithms

Backtracking

Pattern Searching

Divide & Conquer

Geometric Algorithms

Searching

Sorting

Analysis of Algorithms

Mathematical Algorithms

Randomized Algorithms

Recursion

Game Theory

Statistical Algorithms

Tags

Advanced Data Structure Amazon Aptitude Aptitude Arrays Bit Magic C C C++ Computer Networks CPP-Library C Quiz Dynamic Programming Experienced GBlog Geometric Graph Hash Internship Interview Experiences ISRO Java java-stream JavaScript Linked List Mathematical Matrix Microsoft number-digits PHP Program Output Puzzles Python QA - Placement Quizzes QA - Placement Quizzes School Programming Searching series Sorting STL Strings Technical Scripter Tree UGC-NET Web Technologies

Recent Comments

GeeksforGeeks
A computer science portal for geeks

710-B, Advant Navis Business Park,
Sector-142, Noida, Uttar Pradesh -
201305
feedback@geeksforgeeks.org

COMPANY

About Us
Careers
Privacy Policy
Contact Us

LEARN

Algorithms
Data Structures
Languages
CS Subjects
Video Tutorials

PRACTICE

Company-wise
Topic-wise
Contests
Subjective Questions

CONTRIBUTE

Write an Article
Write Interview Experience
Internships
Videos