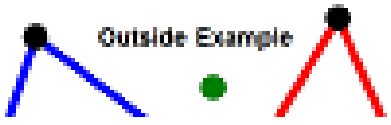
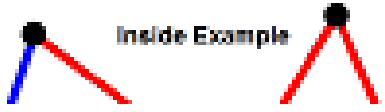
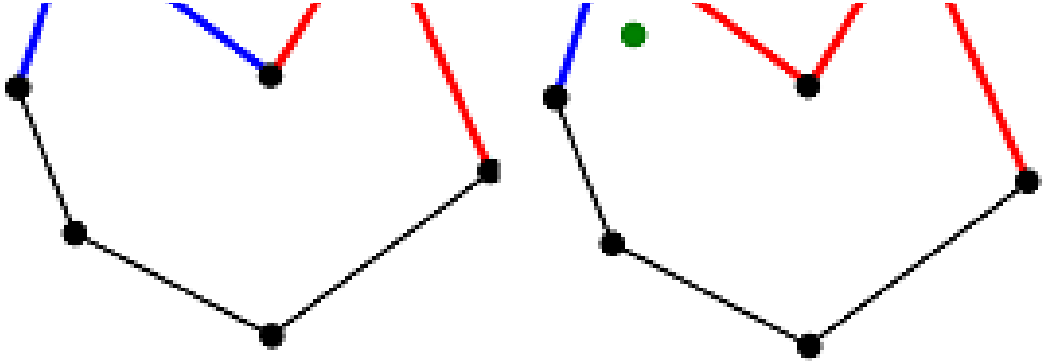
How to check if a given point lies inside or outside a polygon?

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.

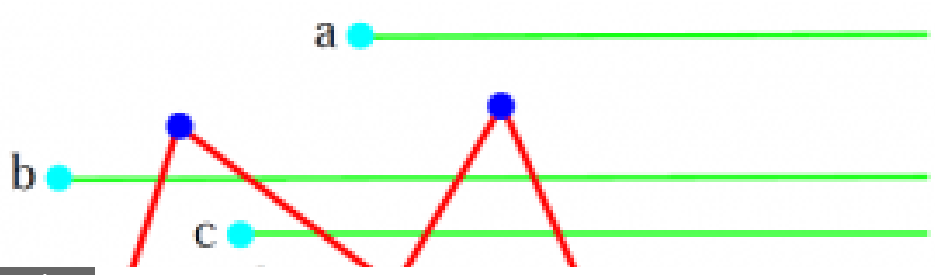
How to check if two given line segments intersect?

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 i
t to infinity

1) Count the number of times the line intersects with polygon edg
es.

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 i
s true, then
   point lies outside.
```



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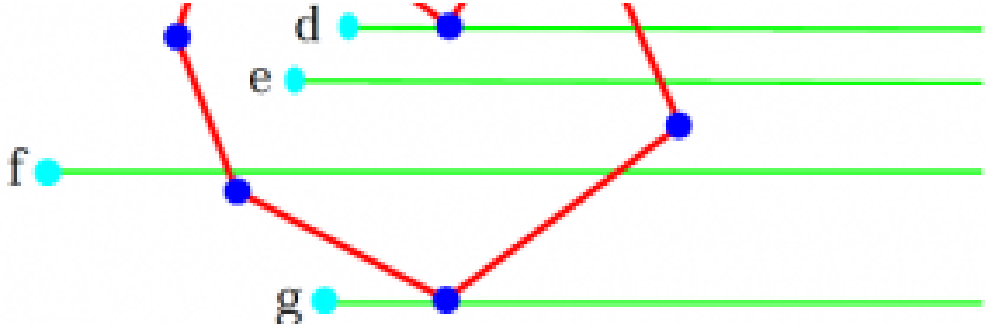

How to handle point ‘g’ in the above figure?

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.

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 po
lygon
// Refer http://www.geeksforgeeks.org/check-if-two-given-line-seg
ments-intersect/
// for explanation of functions onSegment(), orientation() and do
Intersect()
#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)
```


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heisenberg 3*3 + 5*5 + 6*6 = 70

Minimum number of squares whose sum equals to given number n · 26 minutes ago

```
{
    // 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 v
ertices
bool isInside(Point polygon[], int n, Point p)
```

YashLet us suppose we have a single element array...

Fibonacci Search · 40 minutes ago

Mussab ElDash Unfortunately this test case fails it root =...

A program to check if a binary tree is BST or not · 1 hour ago

Mussab ElDash I guess this code needs modification else...

A program to check if a binary tree is BST or not · 1 hour ago

benjamin zhang Performance wise, which is faster? Because the...

Java Programming Language · 1 hour ago

Puneet Singh if(fibMMm1 && arr[offset+1]==x)return offset+1;...

Fibonacci Search · 2 hours ago

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```
{
    // 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 polygo
n
    int count = 0, i = 0;
    do
    {
        int next = (i+1)%n;

        // Check if the line segment from 'p' to 'extreme' inters
ects
        // with the line segment from 'polygon[i]' to 'polygon[ne
xt]'
        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, retu
rn true,
            // otherwise false
            if (orientation(polygon[i], p, polygon[next]) == 0)
               return onSegment(polygon[i], p, polygon[next]);

            count++;
        }
        i = next;
```

- Median of two sorted arrays
- Topological Sorting
- Intersection point of two Linked Lists
- Lowest Common Ancestor in a BST.
- Check if a binary tree is BST or not
- Sorted Linked List to Balanced BST

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```
    } 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;
}
```

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

47 Comments Category: Geometric Tags: geometric algorithms , MathematicalAlgo

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

47 Comments GeeksforGeeks

Marco • 4 months ago

Hi, the algorithm fails when presented with the following point and

I posted a correct version on my blog post: http://marcodiiga.githu

Shudipta Sharma • 4 months ago

polygon: {(4,7), (6,5), (7,6), (8,5), (4,2), (2,5)}
P: (4,5)
according to the above code here count of intersections of point P
outside.

basaisehi • 4 months ago

http://bbs.dartmouth.edu/~fang...

Ashutosh Pandey • 6 months ago

perform grahm-scan u will get it

Arpan Kumar Mishra • 6 months ago

Suppose the vertices of the polygon are:
{{-2, 2},{ -1, 1},{ 2, 2},{ 2 ,-1}, {1, -2},{ -2 -2}}

and the point to check is {-1,-1}
The answer should be true. But it gives false.

Chhavi P. Gupta ↗ Arpan Kumar Mishra • 6 months ago

The problem is the line to infinity from {-1 -1} intersects the

this makes the count 2 while it should be 1.

Reply • Share ›

Jeffry ➚ Chhavi P. Gupta • 6 months ago

So what is the solution to prevent counting twice in

Reply • Share ›

Siddarth Jindal ➚ Jeffry • 4 months ago

if we add

"if(orientation(polygon[next],p,extreme) != 0

before increasing the count, we will be cour
earlier was getting counted twice, once at tl
checking second edge.

Reply • Share ›

Deepesh • a year ago

Please explain this line
" If it is coliear, then we check if the point ‘p’ lies on current side of

I have read 3-4 times, not getting the point

Reply • Share ›

Ashutosh • a year ago

i given vertex (1,1) ; (2,3); (5,4); (4,2) and point for testing are (2,2
yes only for first two point and then say no to other two points alsc
result for same test points please solve this issue.

Ionut Cristian • a year ago

Hello! Take a look at the picture of the link:

http://i.imgur.com/NA1ny7B.jpg

Yellow points are points that have been returned as be inside poly
some lines outside the polygon selected. Help me please fix this b

  • Reply • Share ›

Abhimanyu Dogra • 2 years ago

The algorithm is still incorrect.
As couple of users below mentioned, if the "extreme" ray passes
counted. Which makes the algorithm automatically assume the p
Example :
For polygon {"1,4", "1,6", "2,7", "4,7", "5,6", "2,3"}
Point "3,6" is inside but the algorithm assumes it to be outside.

  • Reply • Share ›

Abhimanyu Dogra ↗ Abhimanyu Dogra • 2 years ago

From wikipedia : The issue is solved as follows: If the inter
a tested polygon side, then the intersection counts only if t
vertex of the side lies below the ray. This is effectively equ
considering vertices on the ray as lying slightly above the r

This is how you fix it :-
replace the following piece of code in the section tagged "g

```
if (o1 != o2 && o3 != o4)
return true;
```

with :- (This code now detects intersection ONLY if the se
ray)

```
if (o1 != o2 && o3 != o4)
{
if (!o4)
```

see mor

3 ▲ | ▼ · Reply · Share ›

CNatka · 2 years ago

The code has a flaw- If the point lies outside of the polygon but on
where the expectation is to get false from the function.
For Example : Polygon {(3,6), (1,0), (5,5)} and point (0,5).

▲ | ▼ · Reply · Share ›

anki_2189 ➦ CNatka · a year ago

Yes you are right **@CNatka** .The code has a flaw @Geeks

▲ | ▼ · Reply · Share ›

Piyush · 2 years ago

what if segment joining point and extreme pass through the vertex

2}, {4,0}, {2, 2}, {0, 0}}, and point is (2,0) it gives NO for that case.

Prashanth Reddy • 2 years ago

Thanks for the info... :)

akshat • 2 years ago

what if the coordinates are very large(order of 10^9) then the multi
multiplication of 2 very large coordinates leading to result of a num
long long int also. i tried to solve it by using the actual equation giv
and subtracted them as follows
(y2-y1/x2-x1)-(y3-y2/x3-x2)
but this sol'n is still not working maybe because slopes cannot be

Deven Bhooshan • 2 years ago

There is a problem in the algorithm .

Suppose that a point to be checked lies inside the polygon and pa
algorithm will fail.
for example suppose there is a polygon having five vertices as foll
0 0
0 4
4 2
1 1
1 0
Then if we check Points (1 2) (2 2) (3 2) above algorithm will not w

4 ^ | v • Reply • Share ›

Nishchay Kala ➚ Deven Bhooshan • 2 years ago

A bit of change is required in code, algorithm is correct thc

2 ^ | v • Reply • Share ›

Deepesh ➚ Nishchay Kala • a year ago

plz suggest the change

^ | v • Reply • Share ›

Deven Bhooshan ➚ Nishchay Kala • 2 years ago

yup

^ | v • Reply • Share ›

trying • 2 years ago

what abt the point which is inside the polygon but the ray passes t outside because of even while it is inside. please check.

5 ^ | v • Reply • Share ›

GeeksforGeeks ➚ trying • 2 years ago

Thanks for pointing this out. We have added this condition

^ | v • Reply • Share ›

clotho • 2 years ago

How about a figure 8 polygon rotated 90 degrees? A line from a pc second loop.

```
/* Paste your code here (You may delete these lines if no
```

1 ^ | v • Reply • Share ›

badri • 2 years ago

For the first polygon ,
Point polygon1[] = {{0, 0}, {10, 0}, {10, 10}, {0, 10}};
say point p(-1,10) , the line intersects 3 times {10, 0} to {10, 10} , {
if its odd then point lies inside the polygon , need to handle this ca

```
/* Paste your code here (You may delete these lines if no
```

2 ^ | v • Reply • Share ›

GeeksforGeeks ➚ badri • 2 years ago

Thanks for pointing this out. We have made changes to ha
point is coliear with sides of polygon, we do following:
If the point lies on the side, we return true, else false. We u
lies or not.
Keep it up!

^ | v • Reply • Share ›

hh • 2 years ago

@geeksforgeeks : Your algorithm has bug.
Consider a triangle and say point lie on one side of triangle .This p
should lie outside(acc. to your algo.) but it lie on the side i.e. inside
Please take a look at this.Thanks.

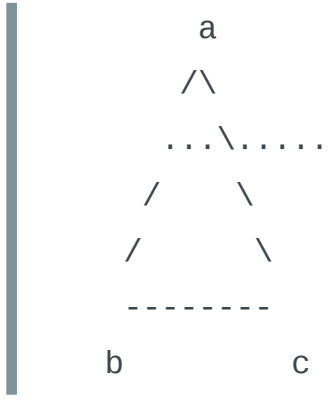
kartik ➚ hh • 2 years ago

I don't understand your question. How can a line from insic
triangle.

See following diagram for example. The line intersects onl

hh ➚ kartik • 2 years ago

see diagram below:



here point lie on side ab of triangle and it intersect t

kartik ➚ hh • 2 years ago

Thanks for providing this case. I think, we s
Following is updated code. We will soon up

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

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

    // Count intersections of the abov
    int count = 0, i = 0;
    do
    {
        if (doIntersect(polygon[i], pc
        {
```

  • Reply • Share ›

GeeksforGeeks ➚ kartik • 2 years ago

@hh: We have updated the code to handle
polygon. Keep it up!

• Reply • Share ›

mohit • 2 years ago

bool onSegment(Point p, Point q, Point r)
{
if (q.x = min(p.x, r.x) &&
q.y = min(p.y, r.y))
return true;
return false;
}

this is wrong . consider (1,2) , (2,4) , (4,5) are not collinear best w
then 3 points are collinear

```
/* Paste your code here (You may delete these lines if no
```

1 ▲ | ▼ • Reply • Share ›

kartik ➦ mohit • 2 years ago

Take a closer look at the usage and working of onSegmen
checked if the three points are colinear. In this function, we

▲ | ▼ • Reply • Share ›

Chaitanya • 2 years ago

I think the best solution would be,
Draw two line from the given point 1 Horizontal & 1 Vertical.
Considering given point as origin , all 4 lines originating from the o
polygon.

```
/* Paste your code here (You may delete these lines if no
```

• Reply • Share ›

kartik ➦ Chaitanya • 2 years ago

This will not work. Consider the diagram of inside example the lines passing through point will intersect, but point is nc

• Reply • Share ›

Chaitanya ➦ kartik • 2 years ago

@Kartik
In case of Inside Example, if you draw a point outsi all the 4 lines originating from the point intersect a p case. Please help me if u find any :S

```
/* Paste your code here (You may delete thes
```

• Reply • Share ›

Chaitanya ➦ kartik • 2 years ago

only 3 out of 4 lines will get intersect if the point is c for point to be inside, all 4 lines originating from tha

```
/* Paste your code here (You may delete thes
```

• Reply • Share ›

Input 1:
3 // no of points
1 1
2 4
2 3
2 2 // x,y coordinates of point to check for inside or outside

Input 2:
5
2 1
8 1
11 4
8 7
2 7
10 2

Output must be :
1> Inside
2> Outside

But above code produces:
1> Outside
2> Outside

1 ^ v • Reply • Share ›

kartik ➚ bit_cracker007 • 2 years ago

I draw a diagram for your first test case. The point (2, 2) se

(2, 4) and (2, 3).

Reply • Share ›

bit_cracker007 ➚ kartik • 2 years ago

That was a typo, check for the below one:
3
1 1
2 3
2 1
2 2

Reply • Share ›

GeeksforGeeks ➚ bit_cracker007 • 2 years ago

Thanks for providing this case. This seems
replace INT_MAX with 200 or some other bi
correct output. We will update the post soo

Reply • Share ›

Hitesh • 2 years ago

Here's another algorithm for the same purpose of checking wheth
or not.

Taking a small example for better understanding the algorithm use

(1) Suppose, we are given 4 polygon points in clockwise order : A

(2) Selected candidate point is : P

(6) Say, ABC = angle made by the line segments AB and BC

(4) Consider the following 4 conditions (1 condition per each poly

(a) ABC >= ABP && ABC >= CBP
(b) BCD >= BCP && BCD >= DCP
(c) CDA >= CDP && CDA >= ADP
(d) DAB >= DAP && DAB >= BAP

(5) If all the above conditions hold good, then the candidate point P

see more

• Reply • Share ›

sniper • 2 years ago

What if the ray passes through two vertex of the polygon. This cor

• Reply • Share ›

GeeksforGeeks sniper • 2 years ago

@sniper: Please take a closer look. If the horizontal line fro
number of intersections would be 4 which is even.
As a side note, if the point is same as one of the vertices,

• Reply • Share ›

sreeni • 2 years ago

You might want to update the line:
q.y = min(r.y, r.y))
to

q.y = min(p.y, r.y))


• Reply • Share ›

GeeksforGeeks sreeni • 2 years ago

@sreeni: Thanks for pointing this out. We have updated th


• Reply • Share ›

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