Term Project

Algorithm Design

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Problem

2010. Sasha the Young Grandmaster

Difficulty: 109

Time limit: 0.5 second

Memory limit: 64MB

Problem Author: folklore
Problem Source: Ural Regional School Programming Contest 2013

Problem

Input

The first line contains an integer n that is the size of the side of the field ($1 \le n \le 10^8$). The second line contains integers x and y that are the coordinates of the cell where Oleg puts the pieces ($1 \le x, y \le n$).

Problem

Output

Output the number of cells that can be hit by king, by knight, by bishop, by rook, and by queen, correspondingly. Follow the format from the sample test.

Problem

Sample

input	output
8 5 2	King: 8 Knight: 6 Bishop: 9 Rook: 14 Queen: 23

Chess Pieces

1. King

a. Chessboard size of 1

K

b. In the Corner

K	x		
x	x		

King

c. On the Edges

					x	K	x
					x	x	x
x	x						
K	x						
x	x						
				x	x	x	
				x	K	x	

King

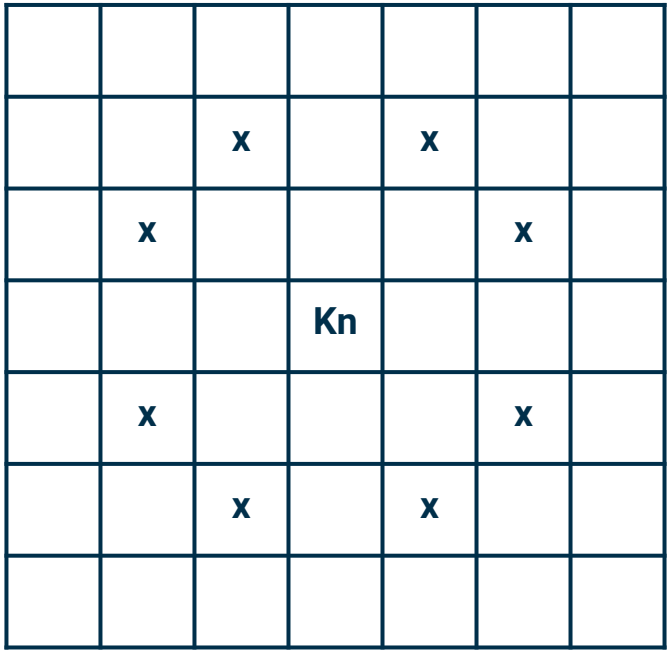
d. In the Middle

				x	x	x	
				x	K	x	
				x	x	x	
x	x	x					
x	K	x					
x	x	x					

Chess Pieces

2. Knight

All possible moves of knight from a point if it is in the middle



Knight

We can achieve all those possible coordinates by

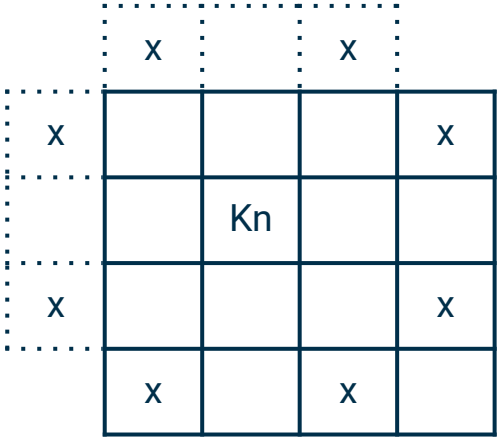
(x + 2, y + 1)
(x + 2, y - 1)
(x - 2, y + 1)
(x - 2, y - 1)
(x + 1, y + 2)
(x + 1, y - 2)
(x - 1, y + 2)
(x - 1, y - 2)

		x		x		
	x				x	
			Kn			
	x				x	
		x		x		

Knight

Validity

So we check all those possible movement of a knight is in the chessboard or not. If one of the coordinates is less than 1 or more than the size of chessboard, that move is invalid. Thus, we exclude that move.



Chess Pieces

3. Rook

a. Horizontal Movement

As you can see, it is always n - 1 movement (n is the size of the chessboard)

x	x	R	x	x	x	x
x	x	x	x	x	R	x

Rook

b. Vertical Movement

As you can see, it is always n - 1 movement (n is the size of the chessboard)

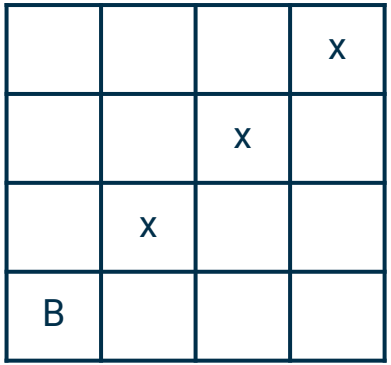
		x			**x**	
		R			**x**	
		x			**x**	
		x			**R**	
		x			**x**	
		x			**x**	
		x			**x**	

Thus, the total possible moves of a rook is (n - 1) x 2.

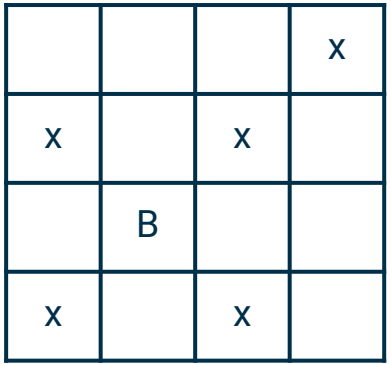
Chess Pieces

4. Bishop

a. A pattern in a bishop movement



(4.1)



(4.2)

In Figure(4.1), no. of possible moves is n - 1.
In Figure(4.2), no. of possible moves is n + 1.

But these tables are not big enough to observe the pattern between no. of possible moves and chessboard size at all so we will take a look at the bigger one.

Bishop

b. Observing the bigger board

x_2					x_1	x_2
x_1	x_2			x_1	x_2	
	x_1	x_2	x_1	x_2		
		B_1	B_2			
	x_1	x_2	x_1	x_2		
x_1	x_2			x_1	x_2	
x_2					x_1	x_2

(4.3)

In Figure(4.3), no. of possible moves of B_1 is n + 3 and no. of possible moves of B_2 is n + 5.

Bishop

By observing those patterns, you can see that the number of possible moves of a bishop is growing by +2 depending on the coordinate of it.

After some researches and according to the pattern, we can calculate all possible moves of a bishop with this formula.

If x or y is more than half of the size of chessboard n, then we set

x = n - (x - 1) [if x is more]

y = n - (y - 1) [if y is more]

Then

no. of all possible moves = n + ((min(x,y) x 2) - 3)

Chess Pieces

5. Queen

The Queen can move horizontally, vertically and diagonally.

Since the Rook can move horizontally and vertically and the Bishop can move diagonally, the number of possible moves of a Queen is the sum of those of a Rook and a Bishop.

$$N(\text{Queen}) = N(\text{Rook}) + N(\text{Bishop})$$

Result

Test Cases

```
1
1 1
King: 0
Knight: 0
Bishop: 0
Rook: 0
Queen: 0
```

```
8
5 2
King: 8
Knight: 6
Bishop: 9
Rook: 14
Queen: 23
```

```
12
4 7
King: 8
Knight: 8
Bishop: 17
Rook: 22
Queen: 39
```

Submission

ID	Date	Author	Problem	Language	Judgement result	Test #	Execution time	Memory used
8366716	19:01:33 8 May 2019	kevin	2010	Python 3.6	Accepted		0.093	376 KB