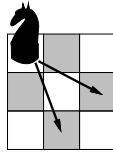


Introduction to Computational Topology: Programming Projects

1 Knight's Tours

A knight is a chess piece that can move either two spaces horizontally and one space vertically or one space horizontally and two spaces vertically.



A **knight's tour** is a sequence of legal moves by a knight starting at some chessboard square and visiting each square exactly once. The following table demonstrates a knight's tour on the 8×8 chessboard:

1	48	13	26	3	50	15	28
24	37	2	49	14	27	4	51
47	12	25	38	63	60	29	16
36	23	62	59	42	39	52	5
11	46	41	56	61	64	17	30
22	35	58	43	40	55	6	53
45	10	33	20	57	8	31	18
34	21	44	9	32	19	54	7

A knight's tour on the standard 8×8 chessboard can be constructed using the following method proposed by Warnsdorff:

Start in any square, and then always move to a square connected to the fewest number of unused squares.

Although this method may not always produce a knight's tour, it often does.

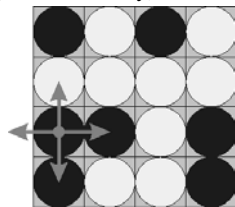
Write a program which constructs a knight's tour starting in arbitrary square. Combine the Warnsdorff method and **backtracking** (backtracking is another name for **depth-first search**).

2 Flip Game

Flip game is played on a rectangular 4×4 field with two-sided pieces placed on each of its 16 squares. One side of each piece is white and the other one is black and each piece is lying either its black or white side up. Each round you flip 3 to 5 pieces, thus changing the color of their upper side from black to white and vice versa. The pieces to be flipped are chosen every round according to the following rules:

Choose any one of the 16 pieces. Flip the chosen piece and also all adjacent pieces to the left, to the right, to the top, and to the bottom of the chosen piece (if there are any). Consider the following position as an example:

```
bwbw
www
bbwb
bwbw
```



Here "b" denotes pieces lying their black side up and "w" denotes pieces lying their white side up. If we choose to flip the 1st piece from the 3rd row (this choice is shown at the picture), then the field will become:

```
bwbw
bwww
www
www
```

The goal of the game is to flip either all pieces white side up or all pieces black side up. You are to write a program that will search for the minimum number of rounds needed to achieve this goal.

Input. The input file consists of 4 lines with 4 characters "w" or "b" each that denote game field position.

Output. Write to the output file a single integer number - the minimum number of rounds needed to achieve the goal of the game

from the given position. If the goal is initially achieved, then write 0. If it's impossible to achieve the goal, then write the word "Impossible" (without quotes).

Input #1 Output for input #1

```
bwbw            Impossible
www
bbwb
bwbw
```

Input #2 Output for input #2

```
bwbw            4
bbwb
bbwb
bwww
```

3 Shortest Path in Square

There are N nonintersecting 5×5 squares inside a square with its left lower corner at $(0, 0)$ and right upper corner at $(100, 100)$. The sides of each 5×5 square are parallel to the x - and y - axes. The problem is to find a shortest path from $(0, 0)$ to $(100, 100)$ which does not cross the 5×5 squares.

Input. The first line of the input file consists of a positive integer N ($1 \leq N \leq 30$). The next N lines contain coordinates (x, y) of the left lower corner of each 5×5 square.

Output. The output file must contain the coordinates of those points of a shortest path where the direction of the path is changed (including the starting and final points).

Sample Input

```
5
5 5
5 15
15 10
15 20
90 90
```

Output for the Sample Input

```
0 0
5 10
20 20
95 90
10 100
```