

(1) experiment result:

```
Testing size 11:
Iterations: 10, Total time(nanoseconds): 16182, Average time(nanoseconds): 1618.2
Iterations: 20, Total time(nanoseconds): 23007, Average time(nanoseconds): 1150.35
Iterations: 30, Total time(nanoseconds): 35371, Average time(nanoseconds): 1179.03
Iterations: 40, Total time(nanoseconds): 50197, Average time(nanoseconds): 1254.92
Iterations: 50, Total time(nanoseconds): 63165, Average time(nanoseconds): 1263.3
Iterations: 60, Total time(nanoseconds): 99635, Average time(nanoseconds): 1660.58
Iterations: 70, Total time(nanoseconds): 88874, Average time(nanoseconds): 1269.63
Iterations: 80, Total time(nanoseconds): 98954, Average time(nanoseconds): 1236.92
Iterations: 90, Total time(nanoseconds): 114658, Average time(nanoseconds): 1273.98
Iterations: 100, Total time(nanoseconds): 142821, Average time(nanoseconds): 1428.21
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Testing size 21:
Iterations: 10, Total time(nanoseconds): 42303, Average time(nanoseconds): 4230.3
Iterations: 20, Total time(nanoseconds): 81957, Average time(nanoseconds): 4097.85
Iterations: 30, Total time(nanoseconds): 144008, Average time(nanoseconds): 4800.27
Iterations: 40, Total time(nanoseconds): 192472, Average time(nanoseconds): 4811.8
Iterations: 50, Total time(nanoseconds): 213558, Average time(nanoseconds): 4271.16
Iterations: 60, Total time(nanoseconds): 247658, Average time(nanoseconds): 4127.63
Iterations: 70, Total time(nanoseconds): 285340, Average time(nanoseconds): 4076.29
Iterations: 80, Total time(nanoseconds): 347083, Average time(nanoseconds): 4338.54
Iterations: 90, Total time(nanoseconds): 387138, Average time(nanoseconds): 4301.53
Iterations: 100, Total time(nanoseconds): 444795, Average time(nanoseconds): 4447.95
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Testing size 31:
Iterations: 10, Total time(nanoseconds): 96728, Average time(nanoseconds): 9672.8
Iterations: 20, Total time(nanoseconds): 164887, Average time(nanoseconds): 8244.35
Iterations: 30, Total time(nanoseconds): 197073, Average time(nanoseconds): 6569.1
Iterations: 40, Total time(nanoseconds): 293930, Average time(nanoseconds): 7348.25
Iterations: 50, Total time(nanoseconds): 444330, Average time(nanoseconds): 8886.6
Iterations: 60, Total time(nanoseconds): 576415, Average time(nanoseconds): 9606.92
Iterations: 70, Total time(nanoseconds): 651286, Average time(nanoseconds): 9304.09
Iterations: 80, Total time(nanoseconds): 678762, Average time(nanoseconds): 8484.52
Iterations: 90, Total time(nanoseconds): 817539, Average time(nanoseconds): 9083.77
Iterations: 100, Total time(nanoseconds): 844125, Average time(nanoseconds): 8441.25
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Testing size 41:
Iterations: 10, Total time(nanoseconds): 121938, Average time(nanoseconds): 12193.8
Iterations: 20, Total time(nanoseconds): 300169, Average time(nanoseconds): 15008.5
Iterations: 30, Total time(nanoseconds): 489467, Average time(nanoseconds): 16315.6
Iterations: 40, Total time(nanoseconds): 655744, Average time(nanoseconds): 16393.6
Iterations: 50, Total time(nanoseconds): 682977, Average time(nanoseconds): 13659.5
Iterations: 60, Total time(nanoseconds): 704601, Average time(nanoseconds): 11743.4
Iterations: 70, Total time(nanoseconds): 795393, Average time(nanoseconds): 11362.8
Iterations: 80, Total time(nanoseconds): 921504, Average time(nanoseconds): 11518.8
Iterations: 90, Total time(nanoseconds): 1130653, Average time(nanoseconds): 12562.8
Iterations: 100, Total time(nanoseconds): 1288098, Average time(nanoseconds): 12881
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Testing size 51:
Iterations: 10, Total time(nanoseconds): 186146, Average time(nanoseconds): 18614.6
Iterations: 20, Total time(nanoseconds): 357936, Average time(nanoseconds): 17896.8
Iterations: 30, Total time(nanoseconds): 638447, Average time(nanoseconds): 21281.6
Iterations: 40, Total time(nanoseconds): 947568, Average time(nanoseconds): 23689.2
Iterations: 50, Total time(nanoseconds): 1168956, Average time(nanoseconds): 23379.1
Iterations: 60, Total time(nanoseconds): 1315044, Average time(nanoseconds): 21917.4
Iterations: 70, Total time(nanoseconds): 1590600, Average time(nanoseconds): 22722.9
Iterations: 80, Total time(nanoseconds): 1528664, Average time(nanoseconds): 19108.3
Iterations: 90, Total time(nanoseconds): 1717364, Average time(nanoseconds): 19081.8
Iterations: 100, Total time(nanoseconds): 1919820, Average time(nanoseconds): 19198.2
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...Program finished with exit code 0
Press ENTER to exit console.
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(2) Complexity:

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for(int i=0; i<n; i++)
    fill(square[i], square[i]+n, 0); // Using STL to initialize =>O(n²)
```

```

while(key<=n*n){
    if(i-1<0) k=n-1;
    else k=i-1;
    if(j-1<0) l=n-1;
    else l=j-1;
    if(square[k][l]) i=(i+1)%n;
    else{
        i=k;
        j=l;
    }
    square[i][j]=key;
    key++;
}

```

=>O(n²)

```

for(i=0 ; i<n; i++){
    copy(square[i], square[i]+n, ostream_iterator<int>(cout, " "));
    cout<<endl;
}

```

=>O(n²)

=>O(n²) + O(n²) + O(n²) = O(n²)

And according to the data, average times of size 11 and 31, are 1200 and 9000 nanoseconds, $31/11 \doteq 2.8$, $9000/1200 \doteq 7.5$, $\sqrt{7.5} \doteq 2.7$, can be conclude that when size become n times the original, average times will also become n² times the original, either.

=>Ans: The complexity of the magic function is O(n²).