

## Maximum size square sub-matrix with all 1s

Given a binary matrix, find out the maximum size square sub-matrix with all 1s.

For example, consider the below binary matrix.

```

0  1  1  0  1
1  1  0  1  0
0  1  1  1  0
1  1  1  1  0
1  1  1  1  1
0  0  0  0  0
    
```

The maximum square sub-matrix with all set bits is

```

1  1  1
1  1  1
1  1  1
    
```

Algorithm:

Let the given binary matrix be  $M[R][C]$ . The idea of the algorithm is to construct an auxiliary size matrix  $S[][]$  in which each entry  $S[i][j]$  represents size of the square sub-matrix with all 1s including  $M[i][j]$  where  $M[i][j]$  is the rightmost and bottommost entry in sub-matrix.

- Construct a sum matrix  $S[R][C]$  for the given  $M[R][C]$ .
  - Copy first row and first columns as it is from  $M[][]$  to  $S[][]$
  - For other entries, use following expressions to construct  $S[][]$ 

If  $M[i][j]$  is 1 then

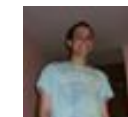
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```

        S[i][j] = min(S[i][j-1], S[i-1][j], S[i-1][j-1]) + 1
    Else /*If M[i][j] is 0*/
        S[i][j] = 0

```

- 2) Find the maximum entry in S[R][C]
- 3) Using the value and coordinates of maximum entry in S[i], print sub-matrix of M[][]

For the given M[R][C] in above example, constructed S[R][C] would be:

```

0  1  1  0  1
1  1  0  1  0
0  1  1  1  0
1  1  2  2  0
1  2  2  3  1
0  0  0  0  0

```

The value of maximum entry in above matrix is 3 and coordinates of the entry are (4, 3). Using the maximum value and its coordinates, we can find out the required sub-matrix.

```

#include<stdio.h>
#define bool int
#define R 6
#define C 5

void printMaxSubSquare(bool M[R][C])
{
    int i,j;
    int S[R][C];
    int max_of_s, max_i, max_j;

    /* Set first column of S[][]*/
    for(i = 0; i < R; i++)
        S[i][0] = M[i][0];

    /* Set first row of S[][]*/
    for(j = 0; j < C; j++)
        S[0][j] = M[0][j];

    /* Construct other entries of S[][]*/
    for(i = 1; i < R; i++)
    {
        for(j = 1; j < C; j++)

```

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```

{
    if(M[i][j] == 1)
        S[i][j] = min(S[i][j-1], S[i-1][j], S[i-1][j-1]) + 1;
    else
        S[i][j] = 0;
}
}

/* Find the maximum entry, and indexes of maximum entry
   in S[][] */
max_of_s = S[0][0]; max_i = 0; max_j = 0;
for(i = 0; i < R; i++)
{
    for(j = 0; j < C; j++)
    {
        if(max_of_s < S[i][j])
        {
            max_of_s = S[i][j];
            max_i = i;
            max_j = j;
        }
    }
}

printf("\n Maximum size sub-matrix is: \n");
for(i = max_i; i > max_i - max_of_s; i--)
{
    for(j = max_j; j > max_j - max_of_s; j--)
    {
        printf("%d ", M[i][j]);
    }
    printf("\n");
}

}

/* UTILITY FUNCTIONS */
/* Function to get minimum of three values */
int min(int a, int b, int c)
{
    int m = a;
    if (m > b)
        m = b;
    if (m > c)
        m = c;
    return m;
}

```



```

/* Driver function to test above functions */
int main()
{
    bool M[R][C] = {{0, 1, 1, 0, 1},
                     {1, 1, 0, 1, 0},
                     {0, 1, 1, 1, 0},
                     {1, 1, 1, 1, 0},
                     {1, 1, 1, 1, 1},
                     {0, 0, 0, 0, 0}};

    printMaxSubSquare(M);
    getchar();
}

```

Time Complexity:  $O(m*n)$  where  $m$  is number of rows and  $n$  is number of columns in the given matrix.

Auxiliary Space:  $O(m*n)$  where  $m$  is number of rows and  $n$  is number of columns in the given matrix.

Algorithmic Paradigm: Dynamic Programming

Please write comments if you find any bug in above code/algorithm, or find other ways to solve the same problem

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7



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**wrestler** • 3 hours ago

Index of max is not needed, simply print the square with all 1 of size max.

^ | v .



**Meenal Mishra** • 4 days ago

Guys check this should be helpful

<http://www.queryhome.com/26246...>

^ | v .



**Bottom Boy** • 4 days ago

typedef struct mat

{

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```

int n, r, c;
}matParm;

matParm sub_mat; // Global Variable
/* Call from main function */

if( row > col)
for (i = 0; i < row - col; i++)
find_sqr_mat (matrix, i, 0, col);
else if (col > row)
for (i = 0; i < col - row ; i++)
find_sqr_mat (matrix, 0, i, row);
else
find_sqr_mat (matrix, 0, 0, col);
/* Print the out put matrix */

```

printf("\n Largest Sub Square Matrix\n");

see more

^ | v .



**prashant jha** · 3 months ago

my c++ code using dp in o(mn) compleity

<http://ideone.com/anhb8j>

^ | v .



**Nikhil Kumar** · 4 months ago

can any one explain the logic of above algorithm ?

why we take min of three values and add 1 if  $M[i][j] == 1$  ?

5 ^ | v .



**Sachin** · 6 months ago

I think we can reduce the space complexity to  $m \times 2$ (m-no. of rows); since the

can store the maximum value in a separate variable, to keep the track of biggest  
drastically reduce the space complexity to  $O(2*m) \sim O(m)$

1 ^ | v .



**Neha Garg** • 7 months ago

complexity can be reduced keep the track of maxofs in the first step .. then no  
finding it and also no need to max\_i and max\_j as all elements are 1 and we d  
maxofs will give dimension of required matrix as this is a square matrix  
plz correct me if i m wrong...

^ | v .



**draganwarrior** • 8 months ago

solution for rectangle <http://ideone.com/DbafRI>

^ | v .



**vishal** → draganwarrior • 7 months ago

your soln doesnt work for the given input:

```
{{1,1,1,1,0,0,1,0,1,1},  
{1,0,1,0,1,1,0,1,0,1},  
{1,1,1,1,1,1,0,0,0,0},  
{0,1,1,1,1,1,1,1,1,0},  
{1,1,1,1,0,1,0,1,0,1}}
```

output will be

```
1 1 1 1 1
```

```
1 1 1 1 1
```

but your output is {{1},{1}}

^ | v .



**M.Sheykhov** → vishal • 6 months ago

it is designed for square matrix

^ | v .



**draganwarrior** → vishal · 7 months ago

YEP u right



**Saurabh Gupta** → vishal · 7 months ago

Buddy , Q. is asking for square matrix and your ex. output is no



**Guest** · 8 months ago

```
#include<iostream>
```

```
using namespace std;
```

```
int Matrix[5][5]= {{0,0,0,0,0},
```

```
{0,1,0,0,0},
```

```
{0,1,1,0,0},
```

```
{0,0,1,1,0},
```

```
{0,0,1,1,0}};
```

```
int IsMatrix(int i,int j,int n)
```

```
{ int x = i, y = j;
```

```
while(x < (i + n))
```

```
{ v = i;
```

[see more](#)



**Nguyễn Hoài Bảo** · 9 months ago





it wrong in sample test:

0 1 0 0

0 0 0 0

0 0 0 0

0 0 0 0

answer must be 1 but it return 0.

^ | v .



**Kartik** → Nguyễn Hoài Bảo · 9 months ago

It prints 1. See <http://ideone.com/EQwwB5>

1 ^ | v .



**jaskaran1** · 10 months ago

I think there seems to be some inconsistency.

If suppose the matrix  $M[][]$  is

1 1 0

1 1 0

0 0 0

then  $S[][]$  according to the logic is

1 1 0

1 2 0

0 0 0

So according to the logic  $S[2][2]$  is the size of the largest square submatrix of which here is 0. But we know that the largest square submatrix in  $M$  is of size 2

1 1 1

1 2 2

2 2 2

2 ^ | v .



GeeksforGeeks → jaskaran1 · 10 months ago

Please note that we copy first row and first column as it is, then fill rest

^ | v ·



jaskaran1 → GeeksforGeeks · 10 months ago

I do understand the point. But then the matrix S is

1 1 0

1 2 0

0 0 0

which is incorrect as  $S[i][j]$  represents the dimension of the largest square sub-matrix with all 1s in the matrix  $(i+1) \times (j+1)$ . So  $S[2][2]$  is 0 which means that the size of the largest square sub-matrix with all 1s in  $3 \times 3$  matrix is 0 which is wrong and the correct answer is 2.

^ | v ·



GeeksforGeeks → jaskaran1 · 10 months ago

Please take a closer look at the implementation and explanation.

*$S[i][j]$  represents size of the square sub-matrix with all 1 rightmost and bottommost entry in sub-matrix.*

^ | v ·



mohammad faizan ali · 11 months ago

Hey every one since i found the above implementation little lengthy :

```
#include<stdio.h>
int count=0;
void modify(int * arr,int x,int y);
int min(int,int,int);
int main()
```

```

        int x,i,y,j;
//      asking for no. of rows and columns
        printf("Enter the  number of rows and columns\n");
        scanf("%d %d ",&x,&y);

        int array[x][y];
//      taking input

```

[see more](#)

1 ^ | v •



**Srikanth** → mohammad faizan ali • 10 months ago

You are trying to modify the given matrix ...here right

```

/* Paste your code here (You may delete these lines if not wri
^ | v •

```



**mohammad faizan ali** • 11 months ago

Hey every one since i found the above implementation little lengthy im posting

```

#include
int count=0;
void modify(int * arr,int x,int y);
int min(int,int,int);
int main()
{

int x,i,y,j;
// asking for no. of rows and columns

```

```
printf("Enter the number of rows and columns: ");
scanf("%d %d",&x,&y);

int array[x][y];
// taking input

for(i=0;i<x;i++)
{
```

[see more](#)

^ | v .



**\_maverick** · a year ago

can anyone help me for finding the maximum cluster of 1's in the given matrix

-> It can be top,bottom,left,right movement from any cell

eg:

```
110001000111
111101011110
000110001101
000000000011
```

in this situation 9

if possible including diagonal movement also !

give me an idea or code anyone pls.....

^ | v .



**someone** → **\_maverick** · 7 months ago

you can do a bfs to get your answer

^ | v .



**pefullarton** · a year ago

This approach is not correct. It would always give a square matrix only, even if possible. E.g.

In

0 1 1 0 1

1 1 0 1 0

1 1 1 1 0

1 1 1 1 0

1 1 1 1 1

0 0 0 0 0

Result would be

1 1 1

1 1 1

1 1 1

instead of

1 1 1 1

1 1 1 1

1 1 1 1

^ | v ·



**pefullarton** → pefullarton · a year ago

Oh didn't see if it the question was about sub-matrix only :|

^ | v ·



**coderAce** · a year ago

Please just don't give the algorithm plainly. Atleast provide some explanations formulated. The way it is presented here, it looks as if you want the readers to

2 ^ | v ·



**prakhar** · a year ago



Python code

```
[sourcecode language="python"]
def find_sub_matrix_size(matrix):
    copy_matrix = deepcopy(matrix)
    for i in range(1, len(matrix)):
        for j in range(1, len(matrix[0])):
            if matrix[i][j] == 1:
                copy_matrix[i][j] = min(copy_matrix[i-1][j],
                copy_matrix[i][j-1],
                copy_matrix[i-1][j-1]) + 1
            else:
                copy_matrix[i][j] = 0
    return max([item for rows in copy_matrix for item in rows])
```

^ | v .



mn · a year ago

```
6 6
8 -3 4 -1 5 18
2 3 4 -3 0 7
6 -2 3 1 1 3
3 0 2 -1 3 1
2 2 2 2 2 2
1 3 1 -1 3 1
```

^ | v .



Pandiyaraj · a year ago

```
#include <iostream>

#define R 6
#define C 5

using namespace std;
```

```

int find_sub_sq_matrix_size(int a[R][C])
{
    int sum, total_sum=0;
    int *aux = (int *)malloc(R* sizeof(int));

    for( int i=0; i<R; i++){
        sum = 0;
        for(int j=0; j<C; j++){
            sum += a[i][j];
        }
        aux[i] = sum;
        total_sum += sum;
    }
}

```

see more

^ | v .



Palash · 2 years ago

This could be done using max area histogram approach too. Just need to keep

I say this because, max area histogram is generally used if the question is to find the maximum area of a rectangle in a histogram. In this question, we need to find a square, so it's better if you learn one approach that

/\* Paste your code here (You may **delete** these lines **if not** writing code)

^ | v .



Palash · 2 years ago

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I say this because, max area histogram is generally used if the question is to find the maximum area of a rectangle in a histogram. In this question, we need to find a square, so it's better if you learn one approach to c

/\* Paste your code here (You may **delete** these lines **if not** writing c

^ | v .



**Sourabh** · 2 years ago

Hi, I saw a few questions around why  $S[i-1][j-1]$  is considered.  
According to my understanding of this, i am posting it here.  
Suppose, we have a solution like this :-

```
0 1 1 1
0 1 1 1
1 1 1 1
```

And suppose we are considering the case for the bottom-right 1.  
Here, the maximum square is of  $2 \times 2$  size with bottom-right at (2,2)(rows, colu  
To find the maximum square, we need to find the minimum extension of 1s in  
form the length of square ending at present case.  
So, here are the cases :-

1 i-1,j ----> This sees till what length i can extend upwards from bottom right c  
2.i, j-1----> To check till what length we can extend leftwards from bottom left c

If we just take minimum of these, it takes care of left and top direction. Howeve  
there are 1's in top left corner of perspective square.  
 $S[i-1][j-1]$  by definition contains a max square at position i-1, j-1 whose top le

[see more](#)

^ | v .



**SR** · 2 years ago

Not sure if  $S[i-1][j-1]$  is needed in this formulae:

```
S[i][j] = min(S[i][j-1], S[i-1][j], S[i-1][j-1]) + 1
```



^ | v .



**blurjp** · 2 years ago

I don't think this works for the sub-matrix is single row or col, you cannot get the loop

like this:

0 1 0 1 0 1 0 1

0 1 1 1 0 0 1 0

then you get the index of max entry is (1, 1) which is wrong.

```
/* Find the maximum entry, and indexes of maximum entry
   in S[][] */
max_of_s = S[0][0]; max_i = 0; max_j = 0;
for(i = 0; i < R; i++)
{
    for(j = 0; j < C; j++)
    {
        if(max_of_s < S[i][j])
        {
            max_of_s = S[i][j];
            max_i = i;
            max_j = j;
        }
    }
}
```

^ | v .



**null\_pointer** → blurjp · a year ago

please read the question carefully, it says "SQUARE SUB MATRIX", you



**gksgeek** · 3 years ago

@GeeksforGeeks: Can we modify this to find largest sum square matrix in ge

^ | v ·



**Shaikh** → gksgeek · 2 years ago

Its sad that in spite of many people asking the rationale behind taking  
 $S[i][j] = \min(S[i-1][j], S[i][j-1], S[i-1][j-1]) + 1$

nobody has come forward to reason it out. One can understand that its  
work through a solution but its quite difficult to figure it out why this step  
what?

I would really appreciate if someone(and @GeeksforGeeks) can come  
behind it.

Thanks.

4 ^ | v ·



**Max** → Shaikh · a month ago

Original:

1111

1110

1110

0111

Sum:

1110

1220

2230

0121

Explanation:

I am indexing from 0 for the sake of this explanation, with the left y-axis zero.

Consider `Sum[1][1]`. We know that this space itself must be a c

[see more](#)

^ | v .



**eclassi** · 3 years ago

Thanks for the algorithm.

^ | v .



**Sunil** · 3 years ago

Nice logic to determine :) credit goes to the person who found out the logic.

^ | v .



**Aleksandar** · 3 years ago

Great algorithm! Did you invent it, or do you know the name of the inventor?

^ | v .



**sankalp** → Aleksandar · 3 years ago

@Aleksandar:

This is a classic dynamic programming problem.. :)

^ | v .



**Kumar** · 3 years ago

what is the algorithm for maximum rectangular sub-matrix having all 1's

1 ^ | v .



**abc** · 3 years ago



Can anyone elaborate a little bit on how do we find a rectangular sub-matrix in

^ | v .



**GeeksforGeeks** → abc · 3 years ago

@abc: We will soon write a separate post for rectangular matrix.

^ | v .



**triti** → GeeksforGeeks · 3 years ago

Can you please give me the link to the rectangular submatrix al

^ | v .



**kartik** → triti · 3 years ago

See if the following link can help.

<http://effprog.blogspot.com/20...>

^ | v .



**wgpshashank** · 3 years ago

Hey I would Like To Share The Concept Used BY Above program

FAQ.

Q.Why we are copying the first column & first row from source matrix to destination.. although its not mandatory but as below we are using the prev,current,next row & col in two auxiliary matrix.

Q.why it uses the min of 3 elements

ans. because if sub-matrix exist into middle of actual matrix we have to take current, next value wrt corresponding  $M[i][j]$

Correct me if i m wrong

^ | v .



**Ashish** · 4 years ago



<http://en.wikipedia.org/wiki/L...>



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