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Лабораторна робота №5
з дисципліни
«Алгоритми і структури даних»

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номер у списку групи: 14

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Київ 2023

Завдання

1. Написати програму розв'язання задачі пошуку (за варіантом) у двовимірному масиві (матриці) методом двійкового пошуку. Алгоритм двійкового пошуку задається варіантом завдання.

2. Розміри матриці m та n взяти самостійно у межах від 7 до 10.

3. При тестуванні програми необхідно підбирати такі вхідні набори початкових значень матриці, щоб можна було легко відстежити коректність виконання пошуку і ця коректність була б протестована для всіх можливих випадків. З метою тестування дозволяється використовувати матриці меншого розміру.

Варіант 14:

Задано матрицю дійсних чисел $A[m,n]$. Окремо у першому рядку і останньому стовпчику визначити присутність заданого дійсного числа X і його місцезнаходження (координати) методом двійкового пошуку (Алгоритм №2), якщо елементи цього рядка і стовпчика впорядковані за незменшенням.

Текст програми:

```
#include <stdio.h>

#define ROWS 7

#define COLS 10

typedef double matrix[ROWS][COLS];

typedef double (*accessFn)(const matrix, int, int);

int binarySearch(const matrix mat, int size, accessFn accesser, int
accessersArg, double x) {

    int left = 0, right = size - 1;

    while (left < right) {

        const int index = (left + right) / 2;

        const double element = accesser(mat, index, accessersArg);

        if (x <= element) right = index;

        else left = index + 1;

    }

    return accesser(mat, left, accessersArg) == x ? left : -1;

}

double nextByRow(const matrix mat, int index, int row) {

    return mat[row][index];

}

double nextByCol(const matrix mat, int index, int col) {

    return mat[index][col];

}

void printMatrix(const matrix mat) {

    for (int i = 0; i < ROWS; i++) {

        for (int j = 0; j < COLS; j++) {
```

```

        printf("%8.2lf", mat[i][j]);
    }

    printf("\n");
}

}

int main(int argc, char* argv[]) {
    const matrix mat = {
        {20.00,22.01,22.01,45.54,50.96,70.01,71.16,83.40,83.40,90.58},
        {74.32,5.38,28.88,27.41,41.06,40.96,46.77,42.23,6.56,90.58},
        {15.64,71.35,32.62,35.16,52.19,70.83,77.72,9.39,72.48,90.58},
        {38.31,49.97,23.60,77.53,48.31,62.62,2.62,62.76,71.57,95.34},
        {22.01,13.63,27.27,44.88,68.88,86.72,8.45,81.72,59.98,100.0},
        {66.33,59.14,96.47,56.10,51.74,5.25,36.04,65.02,34.44,147.3},
        {74.82,93.74,17.70,77.79,14.42,16.78,56.84,39.76,4.06,150.0},
    };

    printf("Initial matrix:\n");

    printMatrix(mat);

    double x;

    printf("Enter an element to search: ");

    scanf("%lf", &x);

    const int pos1 = binarySearch(mat, COLS, nextByRow, 0, x);

    const int pos2 = binarySearch(mat, ROWS, nextByCol, COLS - 1, x);

    if (pos1 == -1) printf("Element %.2lf not found in the first line\n",
x);

    else printf("In the first row element %.2lf is located at (0, %d)\n",
x, pos1);

```

```
    if (pos2 == -1) printf("Element %.2lf not found in the last column\n",  
x);  
  
    else printf("In last column element %.2lf is located at (%d, %d)\n",  
x, pos2, COLS - 1);  
  
    return 0;  
}
```

Тестування програми

1) Матриця:

20	22.01	22.01	45.54	50.96	70.01	71.16	83.4	83.4	90.58
74.32	5.38	28.88	27.41	41.06	40.96	46.77	42.23	6.56	90.58
15.64	71.35	32.62	35.16	52.19	70.83	77.72	9.39	72.48	95.34
38.31	49.97	23.6	77.53	48.31	62.62	2.62	62.76	71.57	95.34
22.01	13.63	27.27	44.88	68.88	86.72	8.45	81.72	59.98	95.34
66.33	59.14	96.47	56.1	51.74	5.25	36.04	65.02	34.44	147.3
74.82	93.74	17.7	77.79	14.42	16.78	56.84	39.76	4.06	150

Результат пошуку числа 22.01:

Initial matrix:

20.00	22.01	22.01	45.54	50.96	70.01	71.16	83.40	83.40	90.58
74.32	5.38	28.88	27.41	41.06	40.96	46.77	42.23	6.56	90.58
15.64	71.35	32.62	35.16	52.19	70.83	77.72	9.39	72.48	95.34
38.31	49.97	23.60	77.53	48.31	62.62	2.62	62.76	71.57	95.34
22.01	13.63	27.27	44.88	68.88	86.72	8.45	81.72	59.98	95.34
66.33	59.14	96.47	56.10	51.74	5.25	36.04	65.02	34.44	147.30
74.82	93.74	17.70	77.79	14.42	16.78	56.84	39.76	4.06	150.00

Enter an element to search: 22.01

In the first row element 22.01 is located at (0, 1)

Element 22.01 not found in the last column

Результат пошуку числа 83.40:

Initial matrix:

20.00	22.01	22.01	45.54	50.96	70.01	71.16	83.40	83.40	90.58
74.32	5.38	28.88	27.41	41.06	40.96	46.77	42.23	6.56	90.58
15.64	71.35	32.62	35.16	52.19	70.83	77.72	9.39	72.48	95.34
38.31	49.97	23.60	77.53	48.31	62.62	2.62	62.76	71.57	95.34
22.01	13.63	27.27	44.88	68.88	86.72	8.45	81.72	59.98	95.34
66.33	59.14	96.47	56.10	51.74	5.25	36.04	65.02	34.44	147.30
74.82	93.74	17.70	77.79	14.42	16.78	56.84	39.76	4.06	150.00

Enter an element to search: 83.40

In the first row element 83.40 is located at (0, 7)

Element 83.40 not found in the last column

Результат пошуку числа 90.58:

```
Initial matrix:
 20.00  22.01  22.01  45.54  50.96  70.01  71.16  83.40  83.40  90.58
 74.32   5.38  28.88  27.41  41.06  40.96  46.77  42.23   6.56  90.58
 15.64  71.35  32.62  35.16  52.19  70.83  77.72   9.39  72.48  95.34
 38.31  49.97  23.60  77.53  48.31  62.62   2.62  62.76  71.57  95.34
 22.01  13.63  27.27  44.88  68.88  86.72   8.45  81.72  59.98  95.34
 66.33  59.14  96.47  56.10  51.74   5.25  36.04  65.02  34.44 147.30
 74.82  93.74  17.70  77.79  14.42  16.78  56.84  39.76   4.06 150.00
Enter an element to search: 90.58
In the first row element 90.58 is located at (0, 9)
In last column element 90.58 is located at (0, 9)
```

Результат пошуку числа 95.34:

```
Initial matrix:
 20.00  22.01  22.01  45.54  50.96  70.01  71.16  83.40  83.40  90.58
 74.32   5.38  28.88  27.41  41.06  40.96  46.77  42.23   6.56  90.58
 15.64  71.35  32.62  35.16  52.19  70.83  77.72   9.39  72.48  90.58
 38.31  49.97  23.60  77.53  48.31  62.62   2.62  62.76  71.57  95.34
 22.01  13.63  27.27  44.88  68.88  86.72   8.45  81.72  59.98 100.00
 66.33  59.14  96.47  56.10  51.74   5.25  36.04  65.02  34.44 147.30
 74.82  93.74  17.70  77.79  14.42  16.78  56.84  39.76   4.06 150.00
Enter an element to search: 95.34
Element 95.34 not found in the first row
In last column element 95.34 is located at (3, 9)
```

Результат пошуку числа 48.5:

```
Initial matrix:
 20.00  22.01  22.01  45.54  50.96  70.01  71.16  83.40  83.40  90.58
 74.32   5.38  28.88  27.41  41.06  40.96  46.77  42.23   6.56  90.58
 15.64  71.35  32.62  35.16  52.19  70.83  77.72   9.39  72.48  90.58
 38.31  49.97  23.60  77.53  48.31  62.62   2.62  62.76  71.57  95.34
 22.01  13.63  27.27  44.88  68.88  86.72   8.45  81.72  59.98 100.00
 66.33  59.14  96.47  56.10  51.74   5.25  36.04  65.02  34.44 147.30
 74.82  93.74  17.70  77.79  14.42  16.78  56.84  39.76   4.06 150.00
Enter an element to search: 48.5
Element 48.50 not found in the first row
Element 48.50 not found in the last column
```

2) Матриця:

1.2	1.2	3.4	5.6	5.6	5.6	7.8	9.1	9.1	10.2
3.4	4.5	5.6	6.7	7.8	9.1	8.9	10.2	1.2	12.3
5.6	6.7	7.8	9.1	8.9	10.2	1.2	2.3	3.4	12.3
7.8	9.1	8.9	10.2	1.2	2.3	3.4	4.5	5.6	14.1
8.9	10.2	1.2	2.3	3.4	4.5	5.6	6.7	7.8	14.1
1.2	3.4	5.6	7.8	9.1	2.3	4.5	6.7	8.9	18.3
3.4	5.6	7.8	9.1	8.9	10.2	1.2	4.5	6.7	18.3

Результат пошуку числа 1.2:

```
Initial matrix:
 1.20  1.20  3.40  5.60  5.60  5.60  7.80  9.10  9.10  10.20
 3.40  4.50  5.60  6.70  7.80  9.10  8.90  10.20  1.20  12.30
 5.60  6.70  7.80  9.10  8.90  10.20  1.20  2.30  3.40  12.30
 7.80  9.10  8.90  10.20  1.20  2.30  3.40  4.50  5.60  14.10
 8.90  10.20  1.20  2.30  3.40  4.50  5.60  6.70  7.80  14.10
 1.20  3.40  5.60  7.80  9.10  2.30  4.50  6.70  8.90  18.30
 3.40  5.60  7.80  9.10  8.90  10.20  1.20  4.50  6.70  18.30
Enter an element to search: 1.2
In the first row element 1.20 is located at (0, 0)
Element 1.20 not found in the last column
```

Результат пошуку числа 5.6:

```
Initial matrix:
 1.20  1.20  3.40  5.60  5.60  5.60  7.80  9.10  9.10  10.20
 3.40  4.50  5.60  6.70  7.80  9.10  8.90  10.20  1.20  12.30
 5.60  6.70  7.80  9.10  8.90  10.20  1.20  2.30  3.40  12.30
 7.80  9.10  8.90  10.20  1.20  2.30  3.40  4.50  5.60  14.10
 8.90  10.20  1.20  2.30  3.40  4.50  5.60  6.70  7.80  14.10
 1.20  3.40  5.60  7.80  9.10  2.30  4.50  6.70  8.90  18.30
 3.40  5.60  7.80  9.10  8.90  10.20  1.20  4.50  6.70  18.30
Enter an element to search: 5.6
In the first row element 5.60 is located at (0, 3)
Element 5.60 not found in the last column
```


Результат пошуку числа 9.1:

```
Initial matrix:
  1.20   1.20   3.40   5.60   5.60   5.60   7.80   9.10   9.10  10.20
  3.40   4.50   5.60   6.70   7.80   9.10   8.90  10.20   1.20  12.30
  5.60   6.70   7.80   9.10   8.90  10.20   1.20   2.30   3.40  12.30
  7.80   9.10   8.90  10.20   1.20   2.30   3.40   4.50   5.60  14.10
  8.90  10.20   1.20   2.30   3.40   4.50   5.60   6.70   7.80  14.10
  1.20   3.40   5.60   7.80   9.10   2.30   4.50   6.70   8.90  18.30
  3.40   5.60   7.80   9.10   8.90  10.20   1.20   4.50   6.70  18.30
Enter an element to search: 9.1
In the first row element 9.10 is located at (0, 7)
Element 9.10 not found in the last column
```

Результат пошуку числа 12.3:

```
Initial matrix:
  1.20   1.20   3.40   5.60   5.60   5.60   7.80   9.10   9.10  10.20
  3.40   4.50   5.60   6.70   7.80   9.10   8.90  10.20   1.20  12.30
  5.60   6.70   7.80   9.10   8.90  10.20   1.20   2.30   3.40  12.30
  7.80   9.10   8.90  10.20   1.20   2.30   3.40   4.50   5.60  14.10
  8.90  10.20   1.20   2.30   3.40   4.50   5.60   6.70   7.80  14.10
  1.20   3.40   5.60   7.80   9.10   2.30   4.50   6.70   8.90  18.30
  3.40   5.60   7.80   9.10   8.90  10.20   1.20   4.50   6.70  18.30
Enter an element to search: 12.3
Element 12.30 not found in the first row
In last column element 12.30 is located at (1, 9)
```

Результат пошуку числа 14.1:

```
Initial matrix:
  1.20   1.20   3.40   5.60   5.60   5.60   7.80   9.10   9.10  10.20
  3.40   4.50   5.60   6.70   7.80   9.10   8.90  10.20   1.20  12.30
  5.60   6.70   7.80   9.10   8.90  10.20   1.20   2.30   3.40  12.30
  7.80   9.10   8.90  10.20   1.20   2.30   3.40   4.50   5.60  14.10
  8.90  10.20   1.20   2.30   3.40   4.50   5.60   6.70   7.80  14.10
  1.20   3.40   5.60   7.80   9.10   2.30   4.50   6.70   8.90  18.30
  3.40   5.60   7.80   9.10   8.90  10.20   1.20   4.50   6.70  18.30
Enter an element to search: 14.1
Element 14.10 not found in the first row
In last column element 14.10 is located at (3, 9)
```

Результат пошуку числа 18.3:

```
Initial matrix:
  1.20  1.20  3.40  5.60  5.60  5.60  7.80  9.10  9.10  10.20
  3.40  4.50  5.60  6.70  7.80  9.10  8.90  10.20  1.20  12.30
  5.60  6.70  7.80  9.10  8.90  10.20  1.20  2.30  3.40  12.30
  7.80  9.10  8.90  10.20  1.20  2.30  3.40  4.50  5.60  14.10
  8.90  10.20  1.20  2.30  3.40  4.50  5.60  6.70  7.80  14.10
  1.20  3.40  5.60  7.80  9.10  2.30  4.50  6.70  8.90  18.30
  3.40  5.60  7.80  9.10  8.90  10.20  1.20  4.50  6.70  18.30
Enter an element to search: 18.3
Element 18.30 not found in the first row
In last column element 18.30 is located at (5, 9)
```

Результат пошуку числа 8.5:

```
Initial matrix:
  1.20  1.20  3.40  5.60  5.60  5.60  7.80  9.10  9.10  10.20
  3.40  4.50  5.60  6.70  7.80  9.10  8.90  10.20  1.20  12.30
  5.60  6.70  7.80  9.10  8.90  10.20  1.20  2.30  3.40  12.30
  7.80  9.10  8.90  10.20  1.20  2.30  3.40  4.50  5.60  14.10
  8.90  10.20  1.20  2.30  3.40  4.50  5.60  6.70  7.80  14.10
  1.20  3.40  5.60  7.80  9.10  2.30  4.50  6.70  8.90  18.30
  3.40  5.60  7.80  9.10  8.90  10.20  1.20  4.50  6.70  18.30
Enter an element to search: 8.5
Element 8.50 not found in the first row
Element 8.50 not found in the last column
```

Результат пошуку числа 22.5:

```
Initial matrix:
  1.20  1.20  3.40  5.60  5.60  5.60  7.80  9.10  9.10  10.20
  3.40  4.50  5.60  6.70  7.80  9.10  8.90  10.20  1.20  12.30
  5.60  6.70  7.80  9.10  8.90  10.20  1.20  2.30  3.40  12.30
  7.80  9.10  8.90  10.20  1.20  2.30  3.40  4.50  5.60  14.10
  8.90  10.20  1.20  2.30  3.40  4.50  5.60  6.70  7.80  14.10
  1.20  3.40  5.60  7.80  9.10  2.30  4.50  6.70  8.90  18.30
  3.40  5.60  7.80  9.10  8.90  10.20  1.20  4.50  6.70  18.30
Enter an element to search: 22.5
Element 22.50 not found in the first row
Element 22.50 not found in the last column
```

3) Матриця:

10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1
4.12	20.69	81.89	-8.8	-34.28	-71.53	76.47	-41.77	-40.15	10.1
1.12	72.56	-24.8	-38.54	-17.98	-70.22	-21.43	49.09	-1.62	10.1
96.86	26.94	30.02	16.62	85.93	-77.95	-89.53	-83.1	-46.09	10.1
-94.62	68.02	23.08	89.97	61.47	-36.72	92.73	53.4	71.31	10.1
8.39	77.29	-52.17	82.97	-10.41	67.79	-52.34	87.31	63.2	10.1
-80.27	71.59	1.85	-59.59	25.95	-77.7	59.37	4.51	-58.7	10.1

Результат пошуку числа 10.1:

```
Initial matrix:
 10.10  10.10  10.10  10.10  10.10  10.10  10.10  10.10  10.10  10.10
  4.12  20.69  81.89  -8.80 -34.28 -71.53  76.47 -41.77 -40.15  10.10
  1.12  72.56 -24.80 -38.54 -17.98 -70.22 -21.43  49.09  -1.62  10.10
 96.86  26.94  30.02  16.62  85.93 -77.95 -89.53 -83.10 -46.09  10.10
-94.62  68.02  23.08  89.97  61.47 -36.72  92.73  53.40  71.31  10.10
  8.39  77.29 -52.17  82.97 -10.41  67.79 -52.34  87.31  63.20  10.10
-80.27  71.59   1.85 -59.59  25.95 -77.70  59.37   4.51 -58.70  10.10
Enter an element to search: 10.1
In the first row element 10.10 is located at (0, 0)
In last column element 10.10 is located at (0, 9)
```

Результат пошуку числа 20.1:

```
Initial matrix:
 10.10  10.10  10.10  10.10  10.10  10.10  10.10  10.10  10.10  10.10
  4.12  20.69  81.89  -8.80 -34.28 -71.53  76.47 -41.77 -40.15  10.10
  1.12  72.56 -24.80 -38.54 -17.98 -70.22 -21.43  49.09  -1.62  10.10
 96.86  26.94  30.02  16.62  85.93 -77.95 -89.53 -83.10 -46.09  10.10
-94.62  68.02  23.08  89.97  61.47 -36.72  92.73  53.40  71.31  10.10
  8.39  77.29 -52.17  82.97 -10.41  67.79 -52.34  87.31  63.20  10.10
-80.27  71.59   1.85 -59.59  25.95 -77.70  59.37   4.51 -58.70  10.10
Enter an element to search: 20.1
Element 20.10 not found in the first row
Element 20.10 not found in the last column
```