Т3

Код на octave

Файл ham_test.m

```
T = [
0, 11, 11, 13, 9, 8, 14, 12, 5, 19, 19, 12, 14, 6, 15;
11, 0, 10, 5, 5, 14, 20, 19, 6, 7, 6, 16, 8, 14, 17;
11, 10, 0, 18, 16, 7, 11, 15, 6, 18, 19, 17, 19, 11, 6;
13, 5, 18, 0, 9, 18, 10, 13, 11, 9, 8, 11, 7, 5, 11;
9, 5, 16, 9, 0, 18, 18, 14, 6, 11, 9, 16, 8, 17, 12;
8, 14, 7, 18, 18, 0, 6, 18, 18, 15, 11, 5, 20, 20, 18;
14, 20, 11, 10, 18, 6, 0, 13, 8, 8, 17, 8, 6, 11, 14;
12, 19, 15, 13, 14, 18, 13, 0, 16, 9, 5, 14, 18, 8, 9;
5, 6, 6, 11, 6, 18, 8, 16, 0, 6, 8, 20, 20, 6, 18;
19, 7, 18, 9, 11, 15, 8, 9, 6, 0, 10, 14, 17, 7, 17;
19, 6, 19, 8, 9, 11, 17, 5, 8, 10, 0, 14, 15, 11, 20;
12, 16, 17, 11, 16, 5, 8, 14, 20, 14, 14, 0, 5, 18, 11;
14, 8, 19, 7, 8, 20, 6, 18, 20, 17, 15, 5, 0, 10, 7;
6, 14, 11, 5, 17, 20, 11, 8, 6, 7, 11, 18, 10, 0, 9;
15, 17, 6, 11, 12, 18, 14, 9, 18, 17, 20, 11, 7, 9, 0
];
tic;
[pb, lb] = branch_n_bound(T)
time_b = toc
```

Файл branch_n_bound.m

```
function [path, length] = branch_n_bound (G)
    sz = size(G);
    A = G + diag(ones(1,sz(1)) + Inf);

    C = [ [0 1:sz(2) 0]' [1:sz(1); A; zeros(1,sz(2))] zeros(sz(1)+2, 1)];
    C = minH(C);
    C(1,1) = C(end, end);
    branch.C = C;
    branch.path = [];
    steps = [branch];
    do
        curBr = minBr(steps);
        C = steps(curBr).C;
        path = steps(curBr).path;
        steps = steps(1, [1:curBr-1, curBr+1:end]);
        C = minH(C);
        [h, coord] = maxO(C);
```

```
        C1 = C;
        arc = [C1(coord(1), 1), C1(1, coord(2))];
        C1 = setInf(C1, C1(1, coord(2)), C1(coord(1), 1));
        C1 = C1([1:coord(1)-1, coord(1)+1:end], 1:end);
        C1 = C1(1:end, [1:coord(2)-1, coord(2)+1:end]);
        C1 = minH(C1);
        C1(1, 1) = C1(1,1) + C1(end, end);
        branch1.C = C1;
        branch1.path = [path; arc];
        C2 = C;
        C2 = setInf(C2, C2(coord(1), 1), C2(1, coord(2)));
        C2(1,1) = C2(1,1) + h;
        branch2.C = C2;
        branch2.path = path;
        [curBr, vBr] = minBr(steps);
        steps = [steps, branch1];
        steps = [steps, branch2];
    until (size(path, 1) == sz(1)-1)
    arc = [C(2,1), C(1,2)];
    path = [path; arc];
    length = C(1,1);
endfunction
```

Файл maxO.m

```
function [prevmin, coord] = maxO (matr)
    coord = [2 2];
    prevmin = 0;
    sz = size(matr);
    for i = 2:sz(1)-1
        for j = 2:sz(2)-1
            if (matr(i, j) == 0)
                minrow = min(matr(i,[2:j-1, j+1:end-1]));
                mincol = min(matr([2:i-1, i+1:end-1], j));
                curmin = minrow + mincol;
                if (curmin >= prevmin)
                    prevmin = curmin;
                    coord = [i j];
                end
            end
        end
    end
endfunction
```

Файл minBr.m

```
function [num, val] = minBr (steps)
    vec = [];
```

```
    for i = 1:length(steps)
        vec(end+1) = steps(i).C(1,1);
    end
    val = Inf;
    num = 0;
    if(!isempty(vec))
        [val, num] = min(vec);
    endif
endfunction
```

Файл minH.m

```
function matr = minH (matr)
    matr(2:end-1, end) = min(matr(2:end-1,2:end-1),[],2);
    matr(2:end-1, 2:end-1) =  matr(2:end-1, 2:end-1) - matr(2:end-1, end);
    matr(end, 2:end-1) = min(matr(2:end-1,2:end-1),[],1);
    matr(2:end-1, 2:end-1) =  matr(2:end-1, 2:end-1) - matr(end, 2:end-1);
    matr(end, end) = sum(matr(2:end-1, end)) + sum(matr(end, 2:end-1));
endfunction
```

Файл setInf.m

```
function matr = setInf (matr, x, y)
    sz = size(matr);
    n = -1;
    m = -1;
    for j = 2:sz(2)-1
        if (matr(1, j) == y)
            n = j;
        end
    end
    for i = 2:sz(1)-1
        if (matr(i, 1) == x)
            m = i;
        end
    end
    if ((n>0)&&(m>0))
      matr(m,n) = Inf;
    endif
endfunction
```

Входные данные для тестирования:

```
0 10 13 14 18
10 0 10 17 6
13 10 0 10 12
14 17 10 0 6
18 6 12 6 0
```

```
0 18 13 5 15
18 0 8 8 6
13 8 0 9 15
5 8 9 0 5
15 6 15 5 0
```

```
0 20 12 19 19 9 9 11 20 20 7 19
20 0 18 20 10 5 11 15 14 7 19 20
12 18 0 20 14 16 16 17 17 9 12 10
19 20 20 0 18 9 5 19 13 12 20 7
19 10 14 18 0 8 11 9 10 14 9 10
9 5 16 9 8 0 7 15 7 12 14 7
9 11 16 5 11 7 0 13 9 18 13 8
11 15 17 19 9 15 13 0 6 16 15 12
20 14 17 13 10 7 9 6 0 5 11 8
20 7 9 12 14 12 18 16 5 0 15 6
7 19 12 20 9 14 13 15 11 15 0 7
19 20 10 7 10 7 8 12 8 6 7 0
```

```
0 11 11 13 9 8 14 12 5 19 19 12 14 6 15
11 0 10 5 5 14 20 19 6 7 6 16 8 14 17
11 10 0 18 16 7 11 15 6 18 19 17 19 11 6
13 5 18 0 9 18 10 13 11 9 8 11 7 5 11
9 5 16 9 0 18 18 14 6 11 9 16 8 17 12
8 14 7 18 18 0 6 18 18 15 11 5 20 20 18
14 20 11 10 18 6 0 13 8 8 17 8 6 11 14
12 19 15 13 14 18 13 0 16 9 5 14 18 8 9
5 6 6 11 6 18 8 16 0 6 8 20 20 6 18
19 7 18 9 11 15 8 9 6 0 10 14 17 7 17
19 6 19 8 9 11 17 5 8 10 0 14 15 11 20
12 16 17 11 16 5 8 14 20 14 14 0 5 18 11
14 8 19 7 8 20 6 18 20 17 15 5 0 10 7
6 14 11 5 17 20 11 8 6 7 11 18 10 0 9
15 17 6 11 12 18 14 9 18 17 20 11 7 9 0
```

```
0 7 12 6 11 10 18 20 12 13 19 14 20 5 15 18 20 5 15 7
7 0 7 19 11 11 6 7 19 8 20 8 8 15 15 11 6 13 5 6
```

```
12 7 0 20 5 18 19 10 8 11 8 11 14 7 7 6 7 11 13 12
6 19 20 0 6 9 8 7 11 20 6 20 16 6 16 18 18 9 8 16
11 11 5 6 0 10 10 15 6 18 10 8 6 18 10 6 7 9 8 19
10 11 18 9 10 0 12 16 16 6 10 20 5 15 5 16 16 13 19 5
18 6 19 8 10 12 0 18 20 15 18 15 19 12 12 10 12 14 10 6
20 7 10 7 15 16 18 0 10 16 12 10 15 12 13 18 8 8 6 19
12 19 8 11 6 16 20 10 0 12 17 20 14 16 14 12 10 8 19 17
13 8 11 20 18 6 15 16 12 0 18 19 16 7 8 19 17 15 18 19
19 20 8 6 10 10 18 12 17 18 0 17 17 14 14 14 7 12 8 19
14 8 11 20 8 20 15 10 20 19 17 0 19 12 9 15 19 18 17 12
20 8 14 16 6 5 19 15 14 16 17 19 0 5 19 18 17 11 6 16
5 15 7 6 18 15 12 12 16 7 14 12 5 0 7 19 9 11 8 7
15 15 7 16 10 5 12 13 14 8 14 9 19 7 0 19 17 10 9 6
18 11 6 18 6 16 10 18 12 19 14 15 18 19 19 0 13 10 7 8
20 6 7 18 7 16 12 8 10 17 7 19 17 9 17 13 0 10 6 16
5 13 11 9 9 13 14 8 8 15 12 18 11 11 10 10 10 0 5 10
15 5 13 8 8 19 10 6 19 18 8 17 6 8 9 7 6 5 0 12
7 6 12 16 19 5 6 19 17 19 19 12 16 7 6 8 16 10 12 0
```

```
0 16 15 15 7 17 9 14 14 19 17 6 9 12 7 8 14 18 20 15 12 5 7 6 11
16 0 9 7 13 7 10 13 13 15 11 12 16 8 10 5 20 12 17 13 13 7 5 12 16
15 9 0 7 20 13 11 20 10 19 12 16 9 9 5 16 16 15 18 19 13 11 17 15 8
15 7 7 0 16 6 15 14 14 11 12 5 8 9 8 6 18 11 6 19 6 15 14 7 18
7 13 20 16 0 14 9 19 15 14 19 19 16 10 9 14 18 18 7 15 7 11 12 6 8
17 7 13 6 14 0 17 7 10 16 11 5 12 8 12 18 15 11 5 16 9 14 15 6 7
9 10 11 15 9 17 0 11 20 12 16 11 19 8 18 7 12 5 9 12 16 6 7 11 20
14 13 20 14 19 7 11 0 11 8 5 9 14 11 9 6 16 14 19 14 17 16 11 13 10
14 13 10 14 15 10 20 11 0 14 18 12 7 5 14 7 12 9 18 11 13 19 20 16 11
19 15 19 11 14 16 12 8 14 0 9 14 15 10 15 9 16 12 11 15 16 17 19 20 17
17 11 12 12 19 11 16 5 18 9 0 11 12 19 14 13 9 17 17 8 16 12 10 10 5
6 12 16 5 19 5 11 9 12 14 11 0 5 16 17 14 8 6 18 16 11 9 16 13 13
9 16 9 8 16 12 19 14 7 15 12 5 0 20 14 15 13 10 14 12 5 7 7 10 14
12 8 9 9 10 8 8 11 5 10 19 16 20 0 12 19 7 6 12 10 20 5 18 8 20
7 10 5 8 9 12 18 9 14 15 14 17 14 12 0 17 9 7 13 14 8 8 10 8 10
8 5 16 6 14 18 7 6 7 9 13 14 15 19 17 0 17 18 14 10 10 12 10 18 19
14 20 16 18 18 15 12 16 12 16 9 8 13 7 9 17 0 12 14 18 13 7 6 20 13
18 12 15 11 18 11 5 14 9 12 17 6 10 6 7 18 12 0 7 19 6 19 14 8 16
20 17 18 6 7 5 9 19 18 11 17 18 14 12 13 14 14 7 0 8 17 18 16 10 7
15 13 19 19 15 16 12 14 11 15 8 16 12 10 14 10 18 19 8 0 7 15 8 7 11
12 13 13 6 7 9 16 17 13 16 16 11 5 20 8 10 13 6 17 7 0 19 11 6 9
5 7 11 15 11 14 6 16 19 17 12 9 7 5 8 12 7 19 18 15 19 0 16 7 18
7 5 17 14 12 15 7 11 20 19 10 16 7 18 10 10 6 14 16 8 11 16 0 18 12
6 12 15 7 6 6 11 13 16 20 10 13 10 8 8 18 20 8 10 7 6 7 18 0 11
11 16 8 18 8 7 20 10 11 17 5 13 14 20 10 19 13 16 7 11 9 18 12 11 0
```

```
0 16 15 15 7 17 9 14 14 19 17 6 9 12 7 8 14 18 20 15 12 5 7 6 11
16 0 9 7 13 7 10 13 13 15 11 12 16 8 10 5 20 12 17 13 13 7 5 12 16
15 9 0 7 20 13 11 20 10 19 12 16 9 9 5 16 16 15 18 19 13 11 17 15 8
15 7 7 0 16 6 15 14 14 11 12 5 8 9 8 6 18 11 6 19 6 15 14 7 18
```

```
7 13 20 16 0 14 9 19 15 14 19 19 16 10 9 14 18 18 7 15 7 11 12 6 8
17 7 13 6 14 0 17 7 10 16 11 5 12 8 12 18 15 11 5 16 9 14 15 6 7
9 10 11 15 9 17 0 11 20 12 16 11 19 8 18 7 12 5 9 12 16 6 7 11 20
14 13 20 14 19 7 11 0 11 8 5 9 14 11 9 6 16 14 19 14 17 16 11 13 10
14 13 10 14 15 10 20 11 0 14 18 12 7 5 14 7 12 9 18 11 13 19 20 16 11
19 15 19 11 14 16 12 8 14 0 9 14 15 10 15 9 16 12 11 15 16 17 19 20 17
17 11 12 12 19 11 16 5 18 9 0 11 12 19 14 13 9 17 17 8 16 12 10 10 5
6 12 16 5 19 5 11 9 12 14 11 0 5 16 17 14 8 6 18 16 11 9 16 13 13
9 16 9 8 16 12 19 14 7 15 12 5 0 20 14 15 13 10 14 12 5 7 7 10 14
12 8 9 9 10 8 8 11 5 10 19 16 20 0 12 19 7 6 12 10 20 5 18 8 20
7 10 5 8 9 12 18 9 14 15 14 17 14 12 0 17 9 7 13 14 8 8 10 8 10
8 5 16 6 14 18 7 6 7 9 13 14 15 19 17 0 17 18 14 10 10 12 10 18 19
14 20 16 18 18 15 12 16 12 16 9 8 13 7 9 17 0 12 14 18 13 7 6 20 13
18 12 15 11 18 11 5 14 9 12 17 6 10 6 7 18 12 0 7 19 6 19 14 8 16
20 17 18 6 7 5 9 19 18 11 17 18 14 12 13 14 14 7 0 8 17 18 16 10 7
15 13 19 19 15 16 12 14 11 15 8 16 12 10 14 10 18 19 8 0 7 15 8 7 11
12 13 13 6 7 9 16 17 13 16 16 11 5 20 8 10 13 6 17 7 0 19 11 6 9
5 7 11 15 11 14 6 16 19 17 12 9 7 5 8 12 7 19 18 15 19 0 16 7 18
7 5 17 14 12 15 7 11 20 19 10 16 7 18 10 10 6 14 16 8 11 16 0 18 12
6 12 15 7 6 6 11 13 16 20 10 13 10 8 8 18 20 8 10 7 6 7 18 0 11
11 16 8 18 8 7 20 10 11 17 5 13 14 20 10 19 13 16 7 11 9 18 12 11 0
```