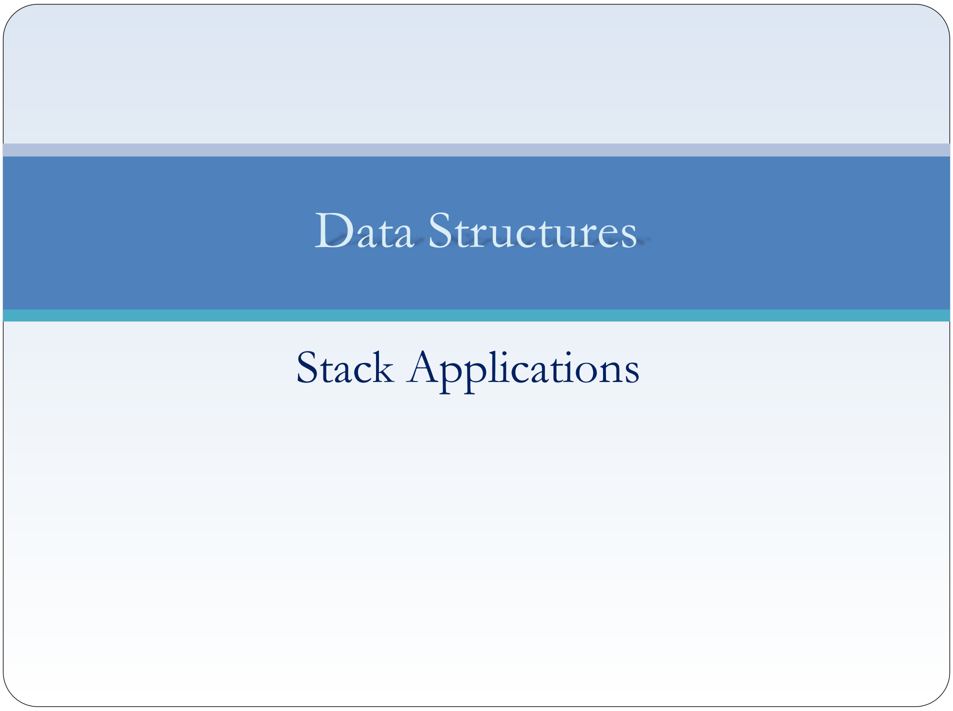
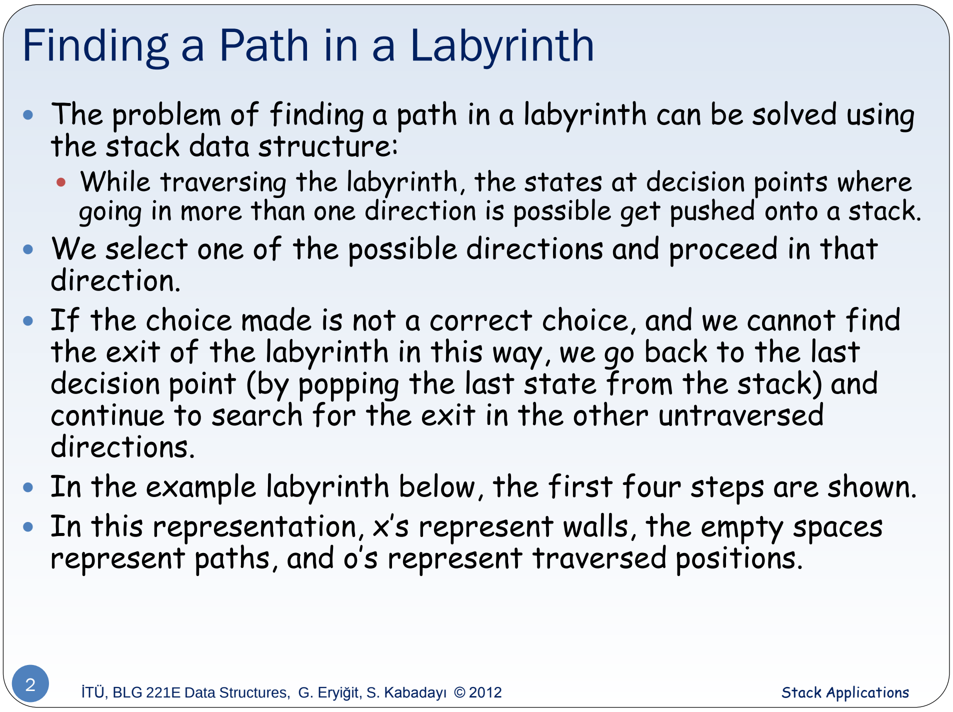


Data Structures

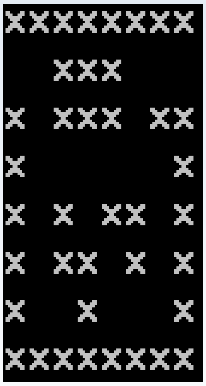
Stack Applications



Finding a Path in a Labyrinth

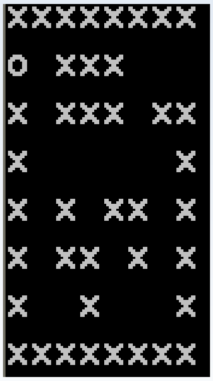
- The problem of finding a path in a labyrinth can be solved using the stack data structure:
  - While traversing the labyrinth, the states at decision points where going in more than one direction is possible get pushed onto a stack.
- We select one of the possible directions and proceed in that direction.
- If the choice made is not a correct choice, and we cannot find the exit of the labyrinth in this way, we go back to the last decision point (by popping the last state from the stack) and continue to search for the exit in the other untraversed directions.
- In the example labyrinth below, the first four steps are shown.
- In this representation, x's represent walls, the empty spaces represent paths, and o's represent traversed positions.

ENTRANCE →

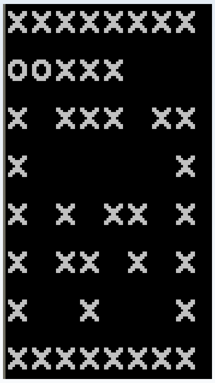


```
XXXXXXXX
  XXX   
X XXX XX
X      X
X X XX X
X XX X X
X  X   X
XXXXXXXX
```

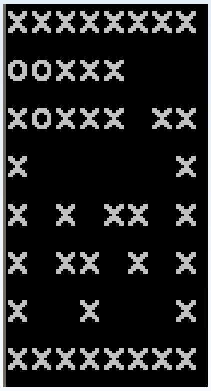
→ EXIT



```
XXXXXXXX
O XXX   
X XXX XX
X      X
X X XX X
X XX X X
X  X   X
XXXXXXXX
```

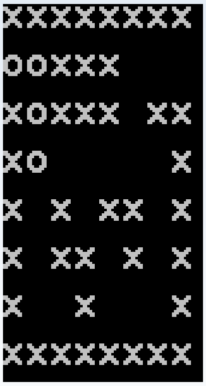


```
XXXXXXXX
OOXXX
X XXX XX
X      X
X X XX X
X XX X X
X  X   X
XXXXXXXX
```

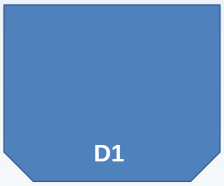


```
XXXXXXXX
OOXXX
XOXXX XX
X      X
X X XX X
X XX X X
X  X   X
XXXXXXXX
```

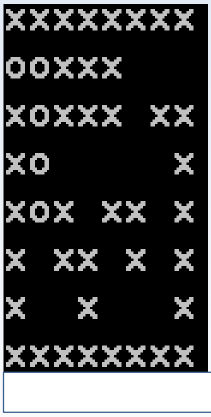
DECISION POINT(D1)



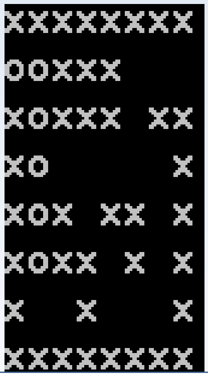
```
XXXXXXXX
OOXXX
XOXXX XX
XO     X
X X XX X
X XX X X
X  X   X
XXXXXXXX
```



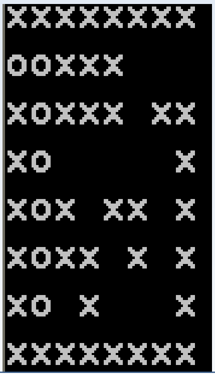
STACK



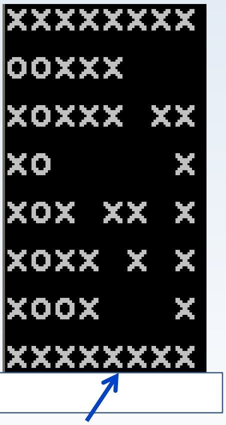
```
XXXXXXXX
OOXXX
XOXXX XX
XO     X
XOX XX X
X XX X X
X  X   X
XXXXXXXX
```



```
XXXXXXXX
OOXXX
XOXXX XX
XO     X
XOX XX X
XOXX X X
X  X   X
XXXXXXXX
```

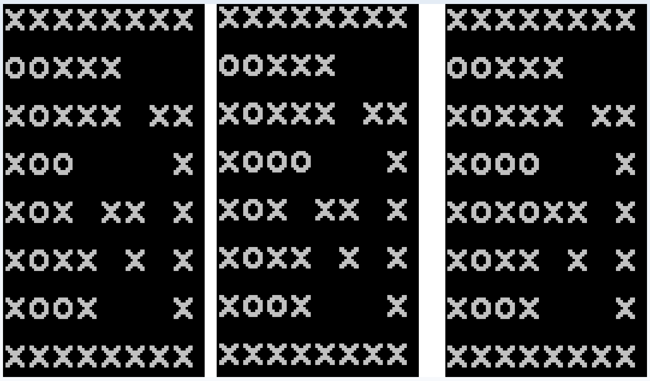


```
XXXXXXXX
OOXXX
XOXXX XX
XO     X
XOX XX X
XOXX X X
XO X   X
XXXXXXXX
```



```
XXXXXXXX
OOXXX
XOXXX XX
XO     X
XOX XX X
XOXX X X
XOOX   X
XXXXXXXX
```

CANNOT MOVE!
GO BACK TO LAST
DECISION POINT



```
XXXXXXXX
OOXXX
XOXXX XX
XOO    X
XOX XX X
XOXX X X
XOOX   X
XXXXXXXX
```

```
XXXXXXXX
OOXXX
XOXXX XX
XOOO   X
XOX XX X
XOXX X X
XOOX   X
XXXXXXXX
```

```
XXXXXXXX
OOXXX
XOXXX XX
XOOO   X
XOXOXX X
XOXX X X
XOOX   X
XXXXXXXX
```

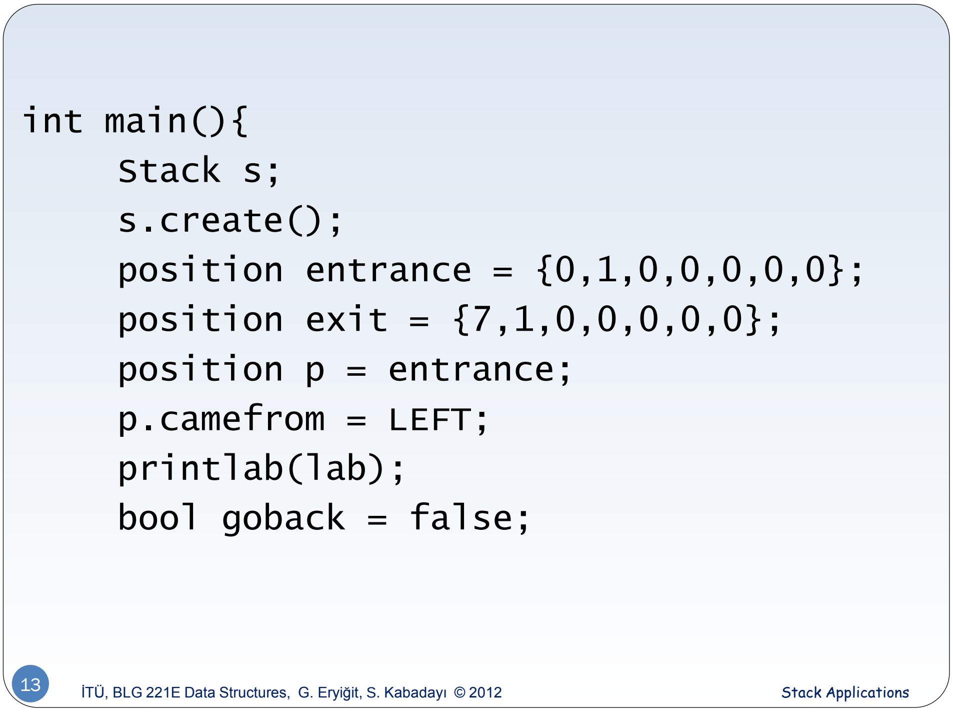
```
typedef struct d{
  int x;
  int y;
  int right;
  int left;
  int down;
  int up;
  int camefrom;
}StackDataType, position;

 struct Node{
  StackDataType data;
  Node *next;
};
```

0/1: cannot go/can go

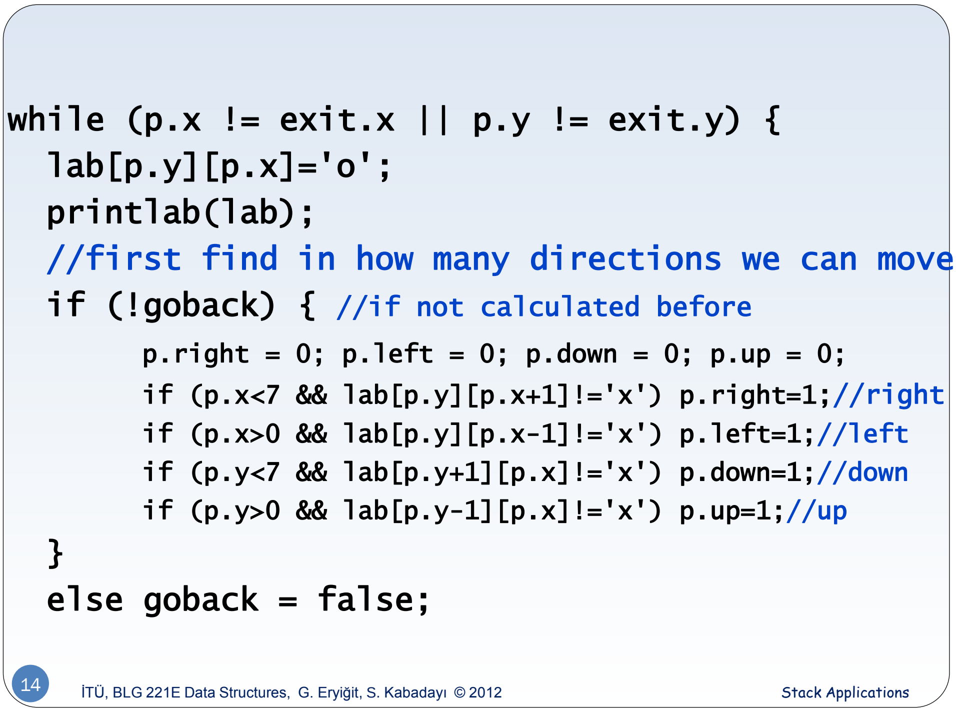
Labyrinth.cpp

```
#define RIGHT   1
#define LEFT    2
#define UP      3
#define DOWN    4

char lab[8][8]={{'x','x','x','x','x','x','x','x'},
                {' ',' ','x','x','x',' ',' ',' '},
                {'x',' ','x','x','x',' ','x','x'},
                {'x',' ',' ',' ',' ',' ',' ','x'},
                {'x',' ','x',' ','x','x',' ','x'},
                {'x',' ','x','x',' ','x',' ','x'},
                {'x',' ',' ','x',' ',' ',' ','x'},
                {'x','x','x','x','x','x','x','x'}};
```

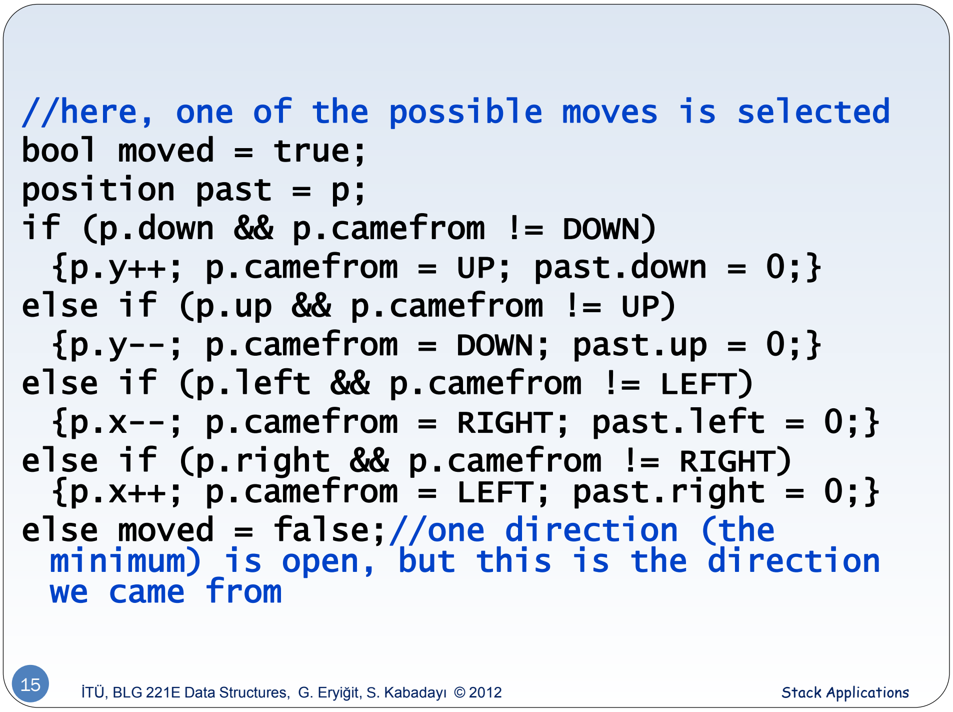
```
void printlab(char l[8][8]) {
     for (int i = 0; i < 8; i++) {
          for (int j = 0; j < 8; j++)
               cout << l[i][j];
          cout << endl;
     }
     cout << endl << endl;
}
```



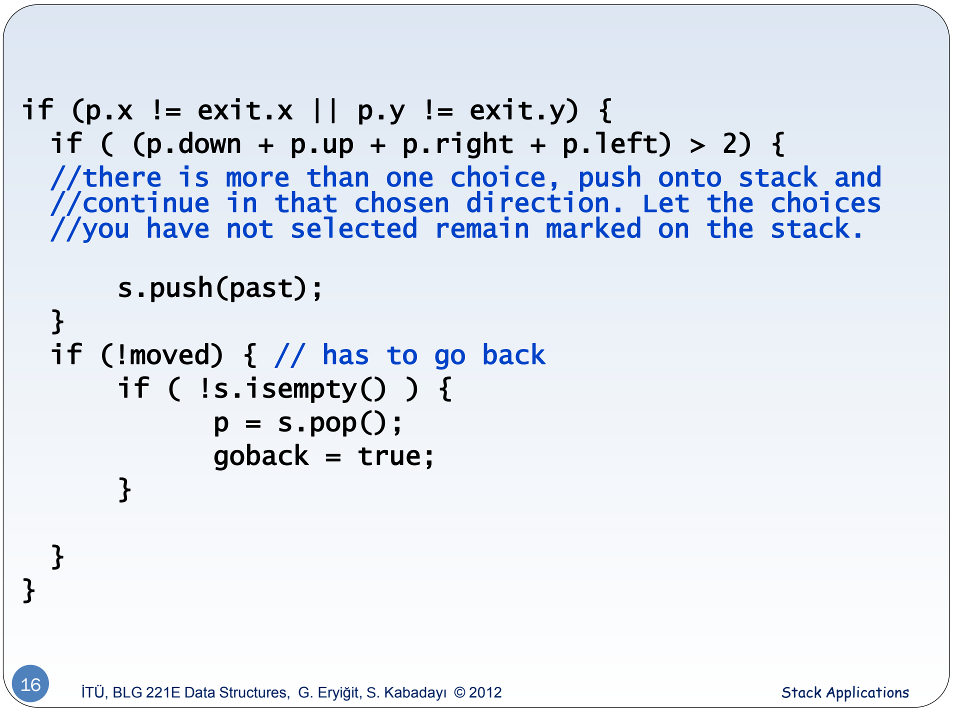
```
int main(){
     Stack s;
     s.create();
     position entrance = {0,1,0,0,0,0,0};
     position exit = {7,1,0,0,0,0,0};
     position p = entrance;
     p.camefrom = LEFT;
     printlab(lab);
     bool goback = false;
```



```
while (p.x != exit.x || p.y != exit.y) {
  lab[p.y][p.x]='o';
  printlab(lab);
  //first find in how many directions we can move
  if (!goback) { //if not calculated before
       p.right = 0; p.left = 0; p.down = 0; p.up = 0;
       if (p.x<7 && lab[p.y][p.x+1]!='x') p.right=1;//right
       if (p.x>0 && lab[p.y][p.x-1]!='x') p.left=1;//left
       if (p.y<7 && lab[p.y+1][p.x]!='x') p.down=1;//down
       if (p.y>0 && lab[p.y-1][p.x]!='x') p.up=1;//up
  }
  else goback = false;
```



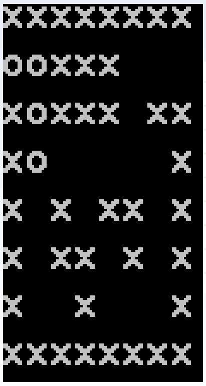
```
//here, one of the possible moves is selected
bool moved = true;
position past = p;
if (p.down && p.camefrom != DOWN)
  {p.y++; p.camefrom = UP; past.down = 0;}
else if (p.up && p.camefrom != UP)
  {p.y--; p.camefrom = DOWN; past.up = 0;}
else if (p.left && p.camefrom != LEFT)
  {p.x--; p.camefrom = RIGHT; past.left = 0;}
else if (p.right && p.camefrom != RIGHT)
  {p.x++; p.camefrom = LEFT; past.right = 0;}
else moved = false;//one direction (the
  minimum) is open, but this is the direction
  we came from
```



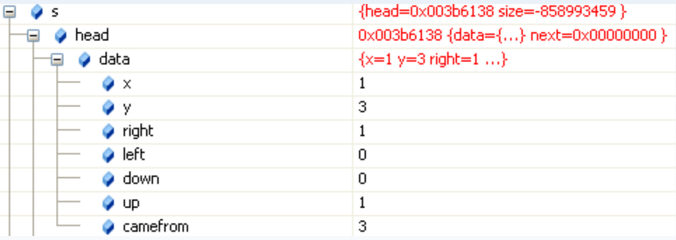
```
if (p.x != exit.x || p.y != exit.y) {
  if ( (p.down + p.up + p.right + p.left) > 2) {
  //there is more than one choice, push onto stack and
  //continue in that chosen direction. Let the choices
  //you have not selected remain marked on the stack.

      s.push(past);
  }
  if (!moved) { // has to go back
      if ( !s.isempty() ) {
            p = s.pop();
            goback = true;
      }

  }
}
```

```
  }//end of while
  lab[p.y][p.x] = 'o';
  printlab(lab);
  cout << "PATH found" << endl;
  s.close();

  return EXIT_SUCCESS;
}
```

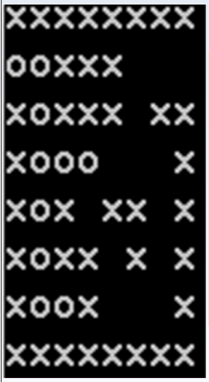
- Assuming that the code works step-by-step, the state of the stack after every stack operation (push and pull) is shown below.



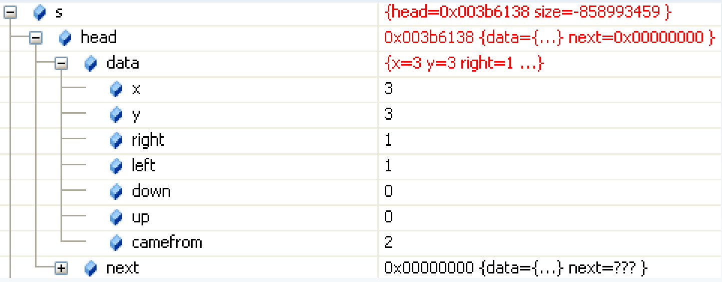
```
XXXXXXXX
OOXXX
XOXXX XX
XO     X
X X XX X
X XX X X
X  X   X
XXXXXXXX
```



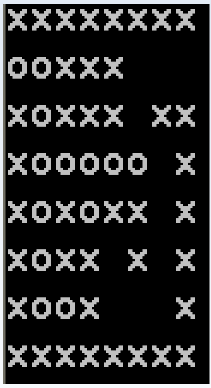
⊟ s	{head=0x003b6138 size=-858993459 }
⊟ head	0x003b6138 {data={...} next=0x00000000 }
⊟ data	{x=1 y=3 right=1 ...}
x	1
y	3
right	1
left	0
down	0
up	1
camefrom	3



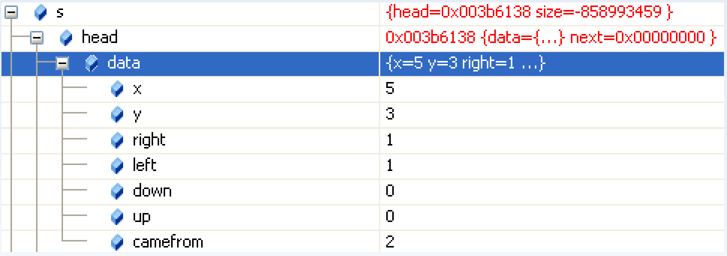
```
XXXXXXXX
OOXXX
XOXXX XX
XOOO   X
XOX XX X
XOXX X X
XOOX   X
XXXXXXXX
```



```
⊟ s                      {head=0x003b6138 size=-858993459 }
  ⊟ head                 0x003b6138 {data={...} next=0x00000000 }
    ⊟ data               {x=3 y=3 right=1 ...}
        x                3
        y                3
        right            1
        left             1
        down             0
        up               0
        camefrom         2
    ⊞ next               0x00000000 {data={...} next=??? }
```



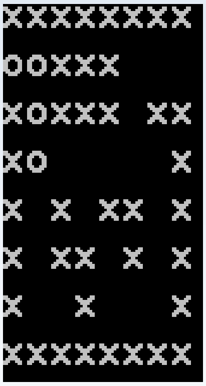
```
XXXXXXXX
OOXXX
XOXXX XX
XOOOOO X
XOXOXX X
XOXX X X
XOOX   X
XXXXXXXX
```



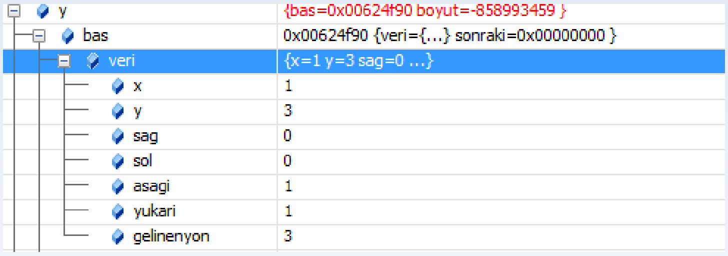
```
⊟ s                      {head=0x003b6138 size=-858993459 }
  ⊟ head                 0x003b6138 {data={...} next=0x00000000 }
    ⊟ data               {x=5 y=3 right=1 ...}
        x                5
        y                3
        right            1
        left             1
        down             0
        up               0
        camefrom         2
```

- In the part of the code where a direction is selected, as a result of preference being given to going right, the state of the stack after every stack operation (push and pull):

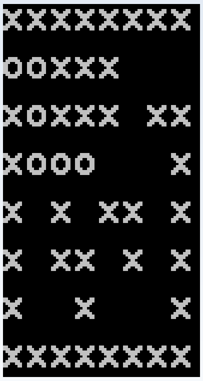
```
if(p.right && p.camefrom != RIGHT)
  {p.x++;p.camefrom=LEFT;past.right=0;}
else if(p.down && p.camefrom != DOWN)
  {p.y++;p.camefrom=UP;past.down=0;}
else if(p.up && p.camefrom != UP)
  {p.y--;p.camefrom=DOWN;past.up=0;}
else if (p.left && p.camefrom != LEFT)
  {p.x--;p.camefrom=RIGHT;past.left=0;}
else moved = false;
```



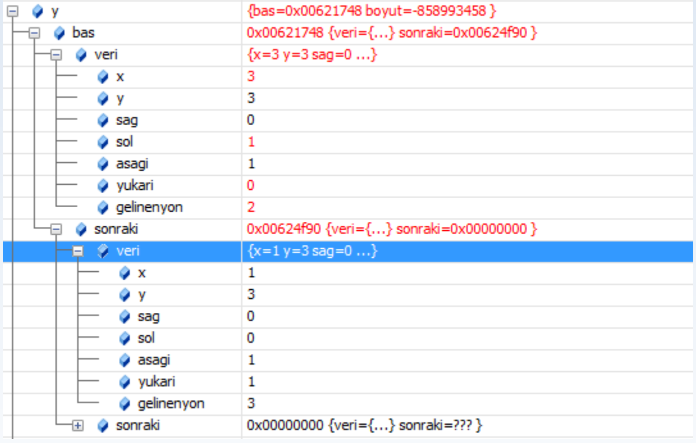
```
XXXXXXXX
OOXXX
XOXXX XX
XO     X
X X XX X
X XX X X
X  X   X
XXXXXXXX
```



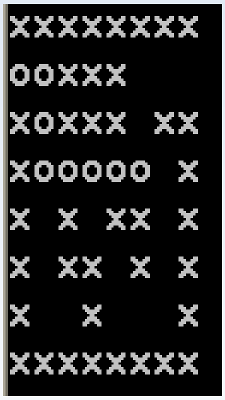
```
⊟ y                      {bas=0x00624f90 boyut=-858993459 }
  ⊟ bas                  0x00624f90 {veri={...} sonraki=0x00000000 }
    ⊟ veri               {x=1 y=3 sag=0 ...}
        x                1
        y                3
        sag              0
        sol              0
        asagi            1
        yukari           1
        gelinenyon       3
```



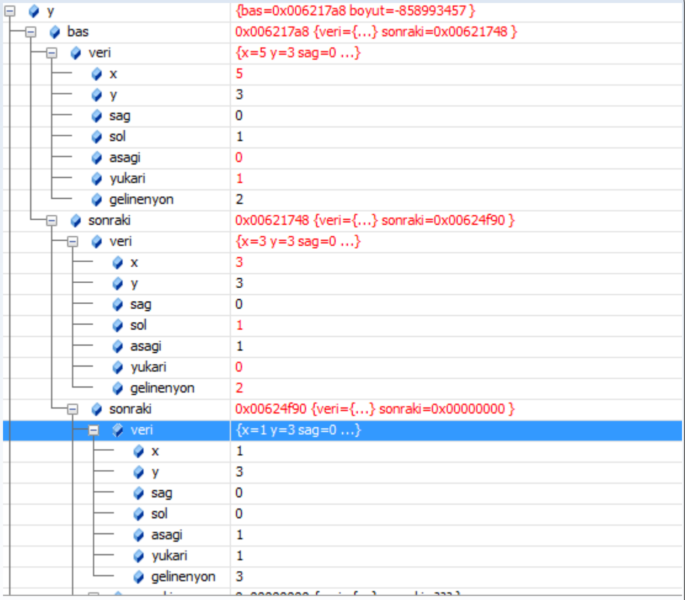
```
XXXXXXXX
OOXXX
XOXXX XX
XOOO   X
X X XX X
X XX X X
X  X   X
XXXXXXXX
```



```
⊟ y                    {bas=0x00621748 boyut=-858993458 }
  ⊟ bas                0x00621748 {veri={...} sonraki=0x00624f90 }
    ⊟ veri             {x=3 y=3 sag=0 ...}
        x              3
        y              3
        sag            0
        sol            1
        asagi          1
        yukari         0
        gelinenyon     2
    ⊟ sonraki          0x00624f90 {veri={...} sonraki=0x00000000 }
      ⊟ veri           {x=1 y=3 sag=0 ...}
          x            1
          y            3
          sag          0
          sol          0
          asagi        1
          yukari       1
          gelinenyon   3
      ⊞ sonraki        0x00000000 {veri={...} sonraki=??? }
```



```
XXXXXXXX
OOXXX
XOXXX XX
XOOOOO X
X X XX X
X XX X X
X  X   X
XXXXXXXX
```



```
⊟ y                      {bas=0x006217a8 boyut=-858993457 }
  ⊟ bas                  0x006217a8 {veri={...} sonraki=0x00621748 }
    ⊟ veri               {x=5 y=3 sag=0 ...}
        x                5
        y                3
        sag              0
        sol              1
        asagi            0
        yukari           1
        gelinenyon       2
    ⊟ sonraki            0x00621748 {veri={...} sonraki=0x00624f90 }
      ⊟ veri             {x=3 y=3 sag=0 ...}
          x              3
          y              3
          sag            0
          sol            1
          asagi          1
          yukari         0
          gelinenyon     2
      ⊟ sonraki          0x00624f90 {veri={...} sonraki=0x00000000 }
        ⊟ veri           {x=1 y=3 sag=0 ...}
            x            1
            y            3
            sag          0
            sol          0
            asagi        1
            yukari       1
            gelinenyon   3
```