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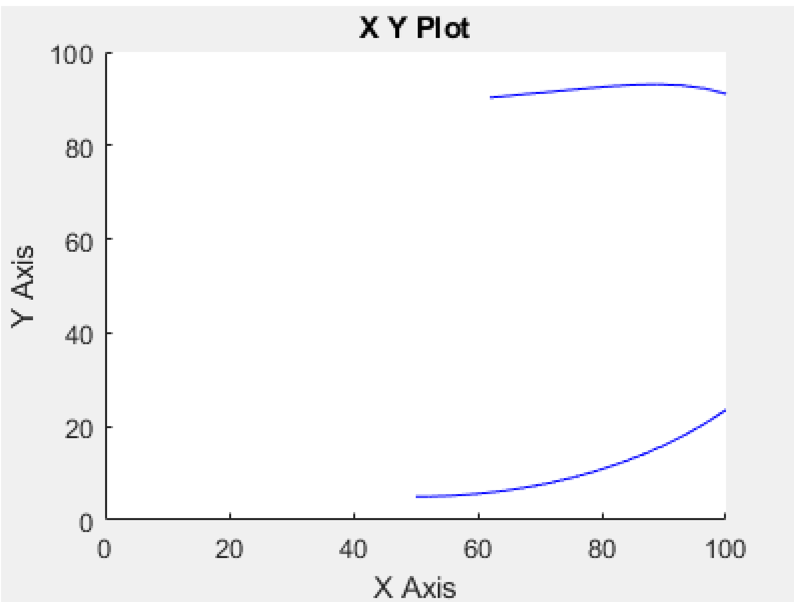
Link: https://drive.matlab.com/sharing/c756aebc-d50b-4e26-9870-92c1306a466f

1. Braitenberg vehicles (page 127)

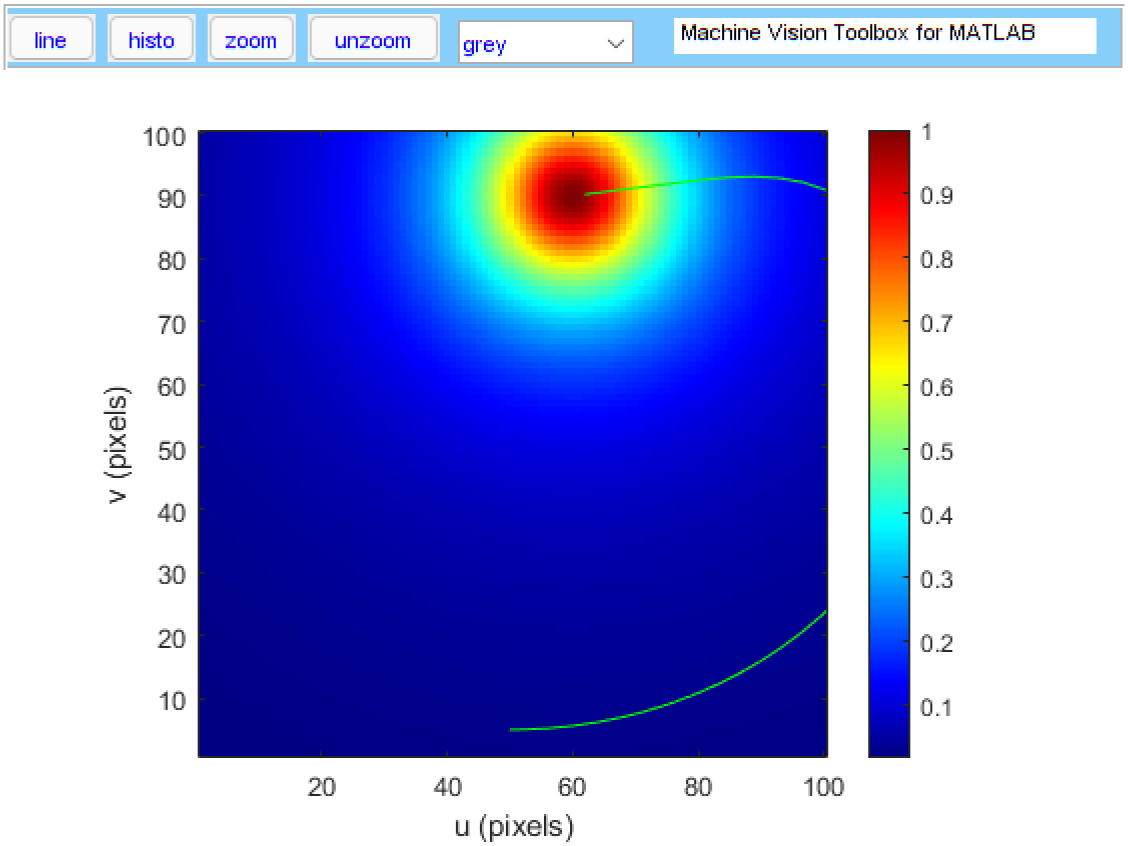
a) Experiment with different starting configurations and control gains.

To change [x, y, theta] you just have to double click the Bycicle block and change the parameters, his modifications can bee seen in sl_braitenberg_experiment.slx.

```
clear
close all
clf

sim('sl_braitenberg_experiment');
```

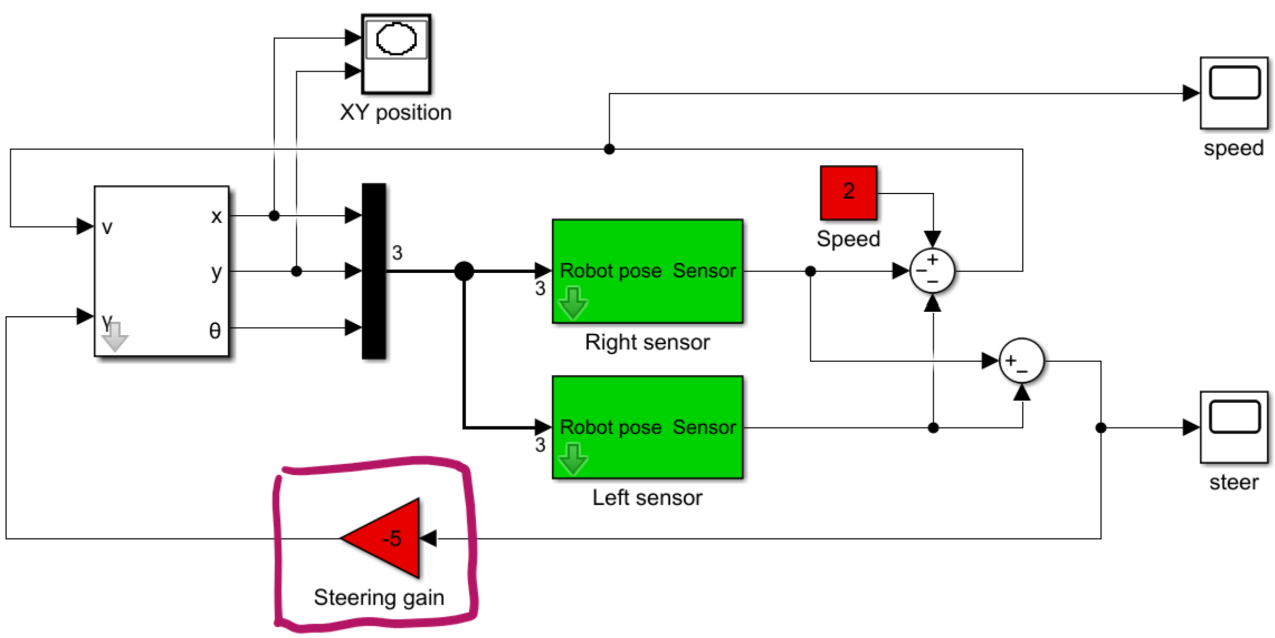



```
[X, Y] = meshgrid(1:100, 1:100);
field = sensorfield(X, Y);
idisp(field, 'ynormal', 'colormap', 'jet', 'bar')
hold on
plot(xout(:, 1), xout(:, 2), 'g')
```



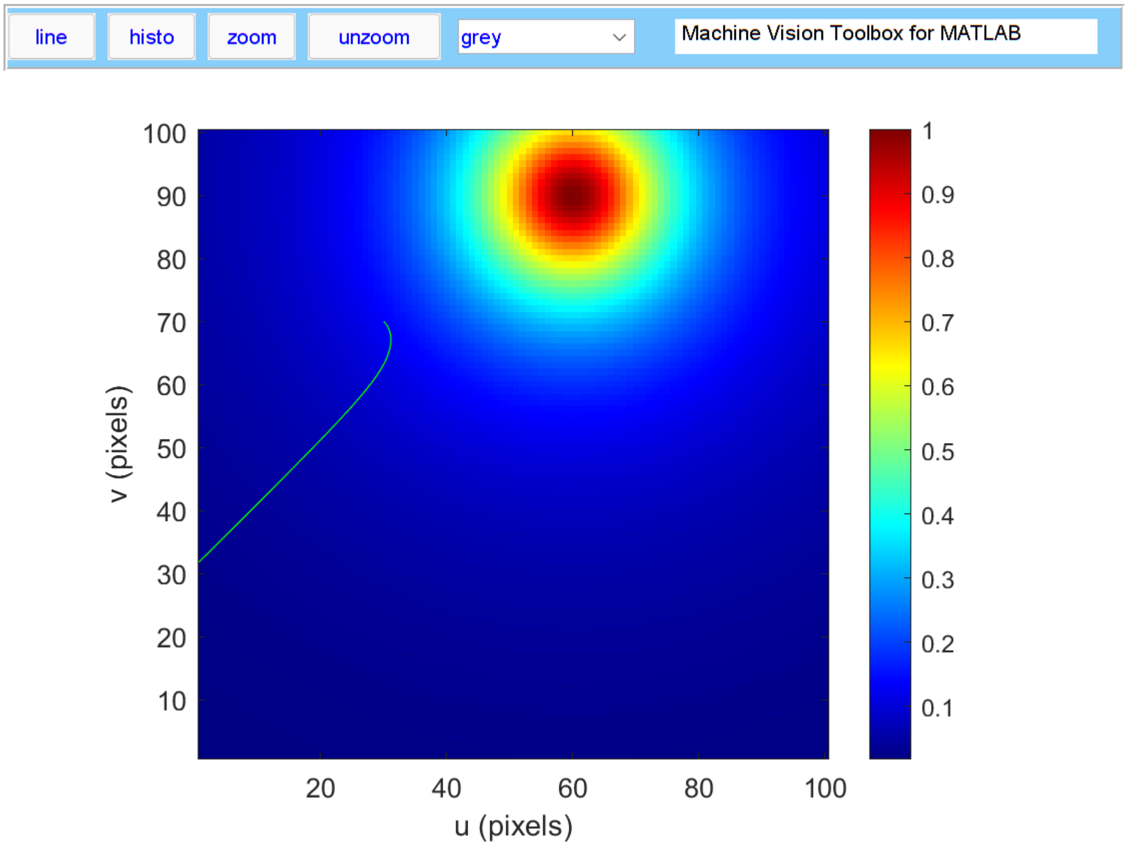
b) Modify the signs on the steering signal to make the vehicle light-phobic.

I just change the steering gain to a negative number, this modifications can bee seen in sl_braitenberg_light_phobic.slx.



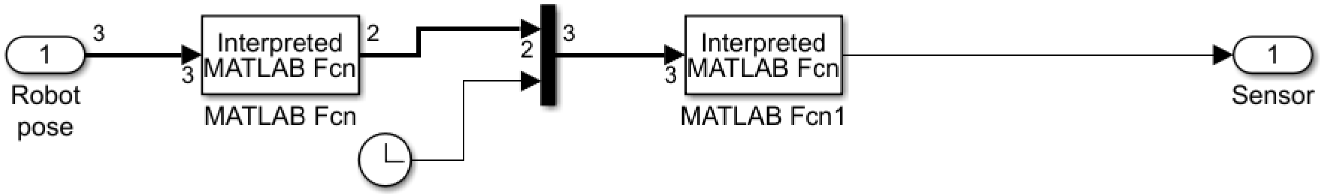

```
clear
```

```
close all
clf

sl_braitenberg_light_phobic

sim('sl_braitenberg_light_phobic');
[X, Y] = meshgrid(1:100, 1:100);
field = sensorfield(X, Y);
idisp(field, 'ynormal', 'colormap', 'jet', 'bar')
hold on
plot(xout(:, 1), xout(:, 2), 'g')
```

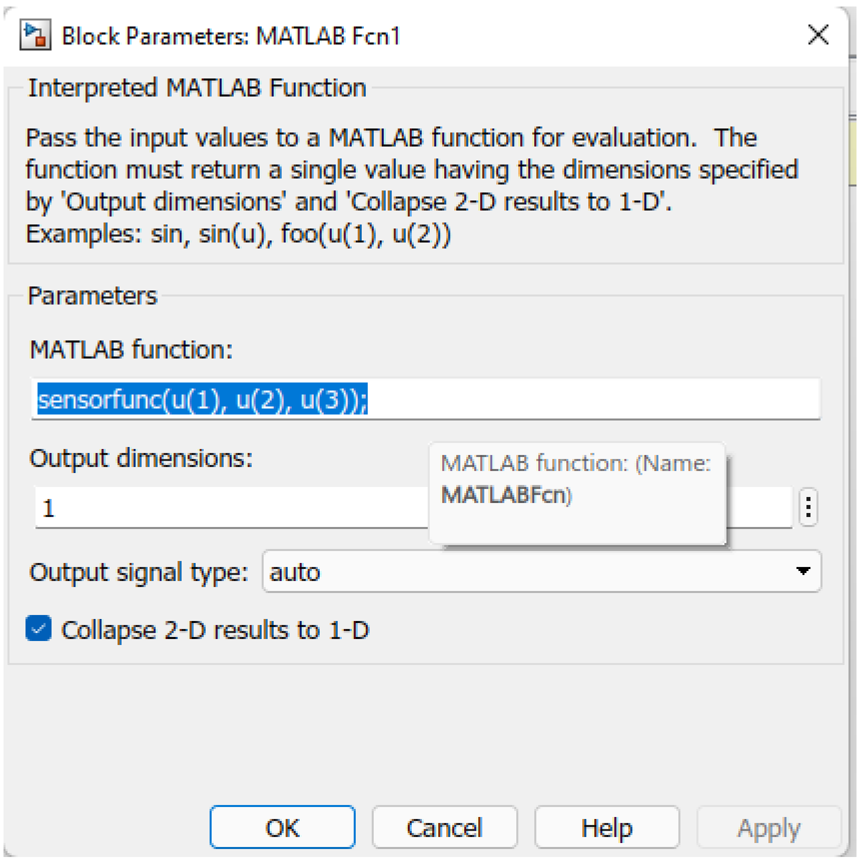


c) Modify the sensorfield function so that the peak moves with time.

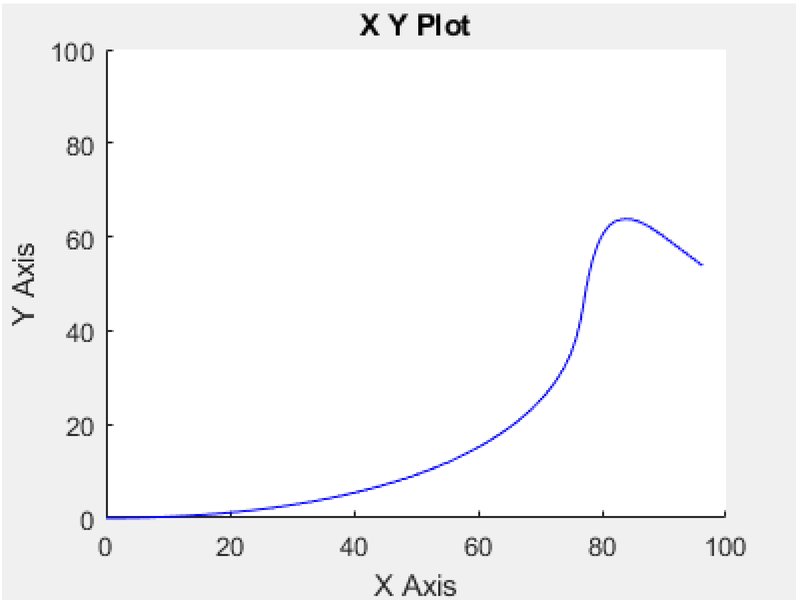
I modified the sensor function to carry out this task (sensorfield2.m) and the sensors block of sl_braitenberg, adding a clock and changing the number of parameters that we pass. this modifications can bee seen in sl_braitenberg_peak_time.slx.



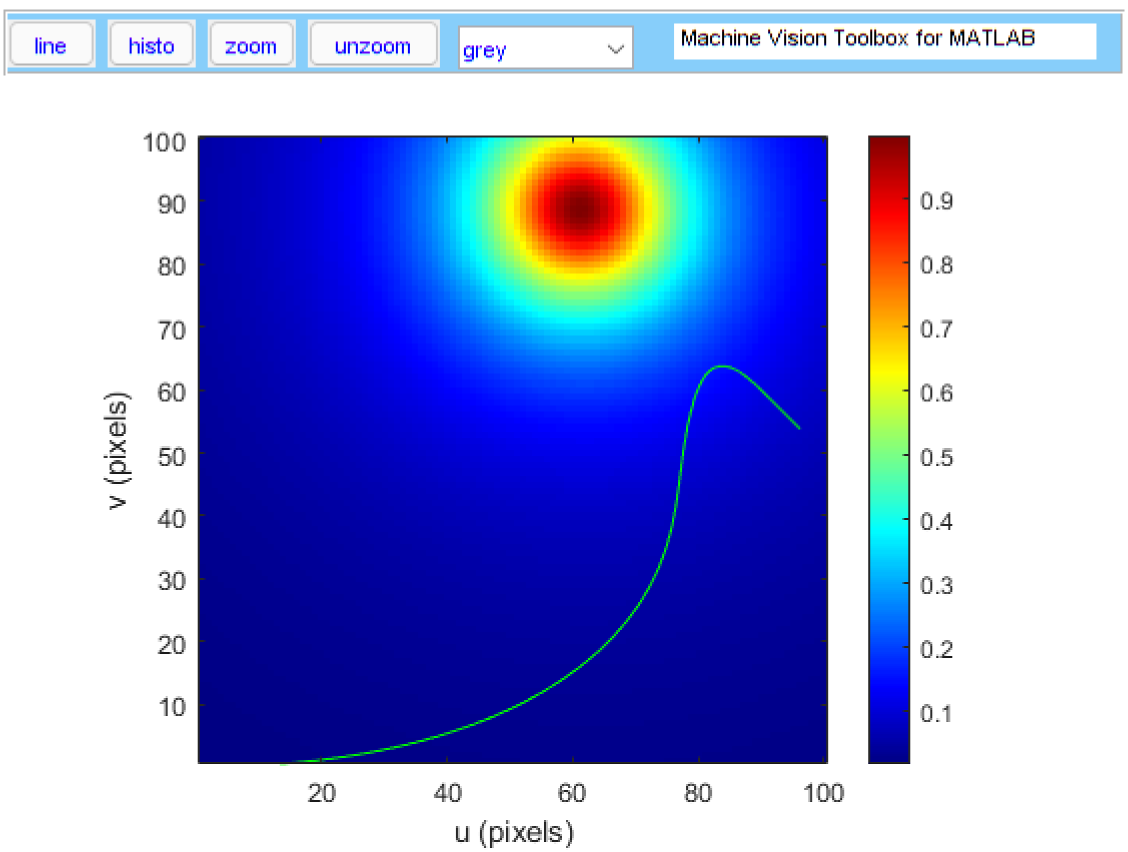
Model a sensor that is rigidly attached to the robot.
From robot pose (x,y, theta) we compute the position of
the sensor at offset (dx,dy) and evaluate the value
of the sensor function at that position.




```
clear
close all
clf

sim('sl_braitenberg_peak_time');
```

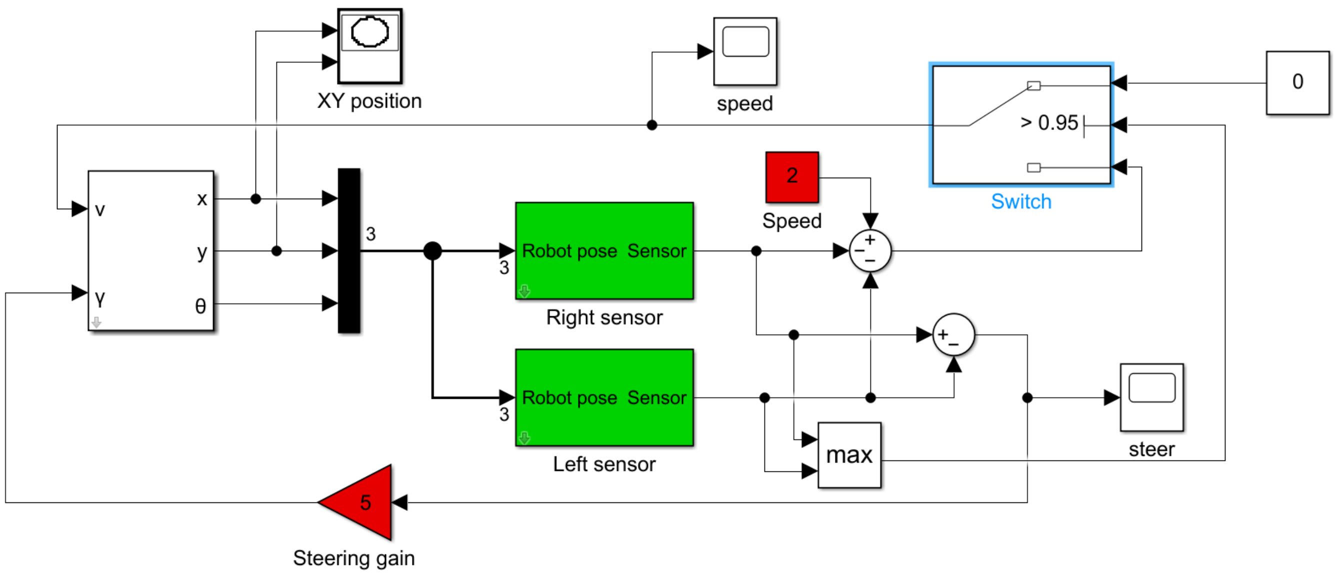



```
[X, Y] = meshgrid(1:100, 1:100);
time = 0:0.1:99*0.1;
field = sensorfield2(X, Y, time);
idisp(field, 'ynormal', 'colormap', 'jet', 'bar')
hold on
plot(xout(:, 1), xout(:, 2), 'g')
```

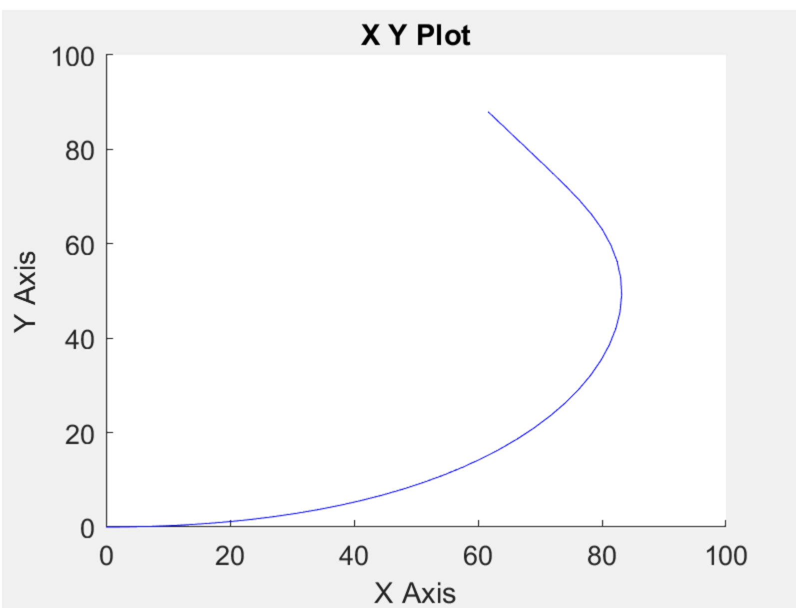


d) The vehicle approaches the maxima asymptotically. Add a stopping rule so that the vehicle stops when the when either sensor detects a value greater than 0.95.

The modifiecation I did to sl_breitenberg, this modifications can bee seen in sl_braitenberg_stop_rule.slx.




```
clear
close all
clf

sim('sl_braitenberg_stop_rule');
```

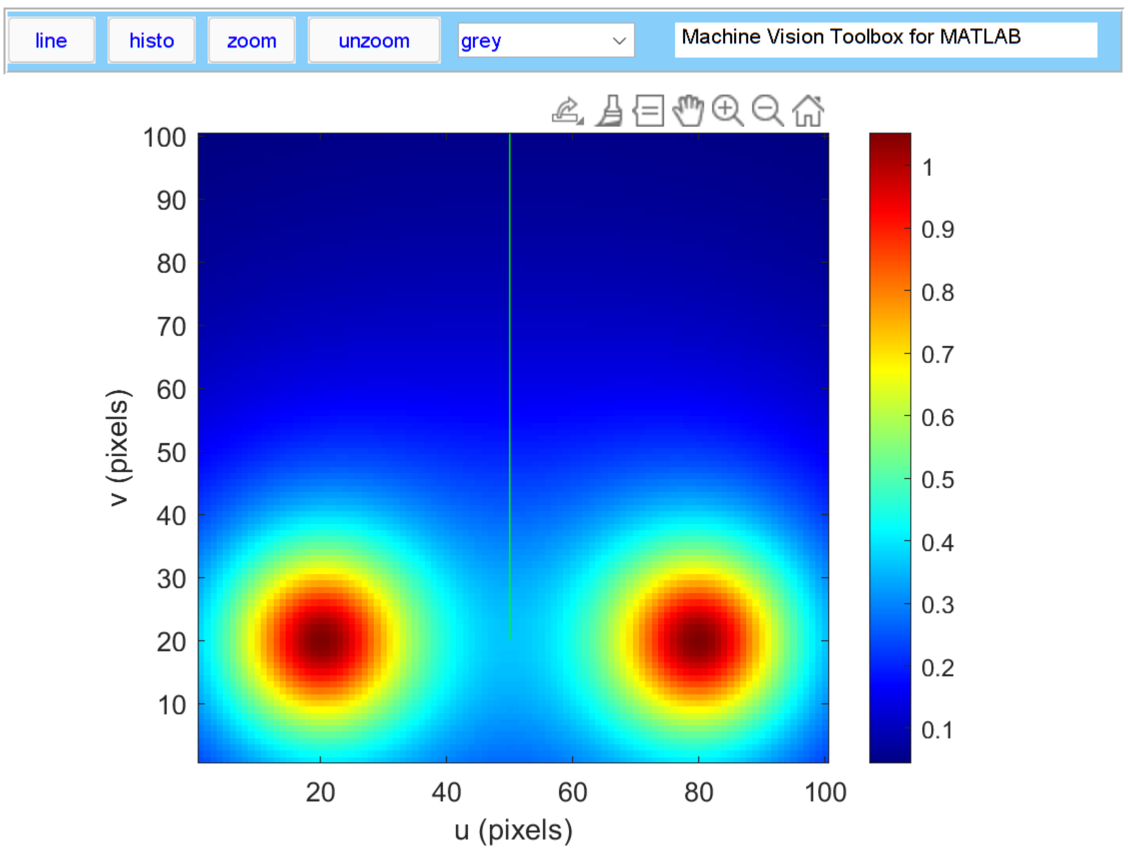



```
[X, Y] = meshgrid(1:100, 1:100);
field = sensorfield(X, Y);
idisp(field, 'ynormal', 'colormap', 'jet', 'bar')
hold on
plot(xout(:, 1), xout(:, 2), 'g')
```

e) Create a scalar field with two peaks. Can you create a starting pose where the robot gets confused?

I modified the function sensorfield, the modifications can bee seen in sensorfield3.m. I modified also the callings to the functions of the sensors to sensorfield3, this modifications can bee seen in sl_braitenberg_two_peaks.slx.

```
clear
close all
clf

sim('sl_braitenberg_two_peaks');
[X, Y] = meshgrid(1:100, 1:100);
field = sensorfield3(X, Y);
idisp(field, 'ynormal', 'colormap', 'jet', 'bar')
hold on
plot(xout(:, 1), xout(:, 2), 'g')
```



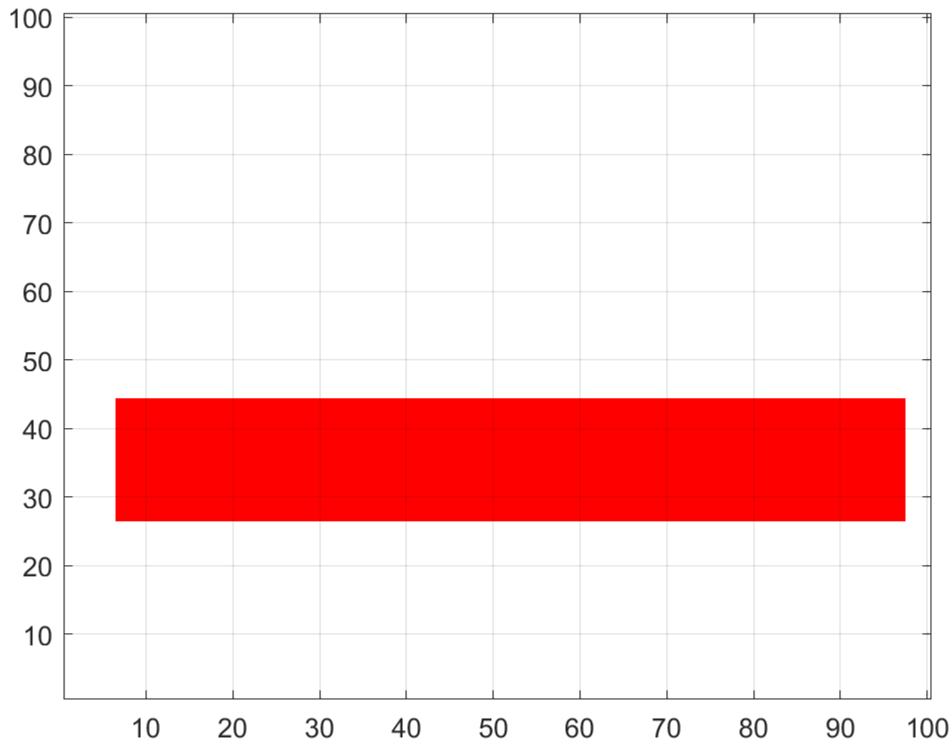
3. Bug algorithms (page 128)

a) Using the function makemap create a new map to challenge bug2. Try different starting points.

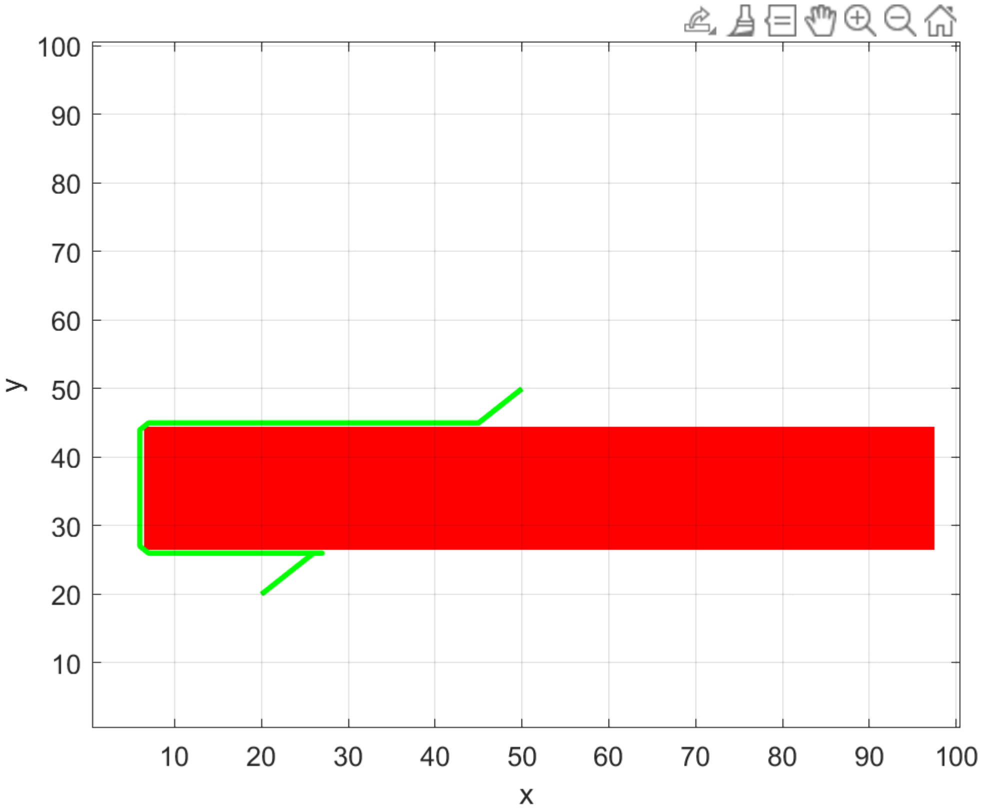
```
clear
close all
clf

map = makemap(100);
```

```
makemap:
  left button, click and drag to create a rectangle
```

```
  or type the following letters in the figure window:
  p - draw polygon
  c - draw circle
  e - erase map
  u - undo last action
  q - leave editing mode
point1 = 1×2
    7.4700   43.6387
point2 = 1×2
   97.2166   26.9964
```



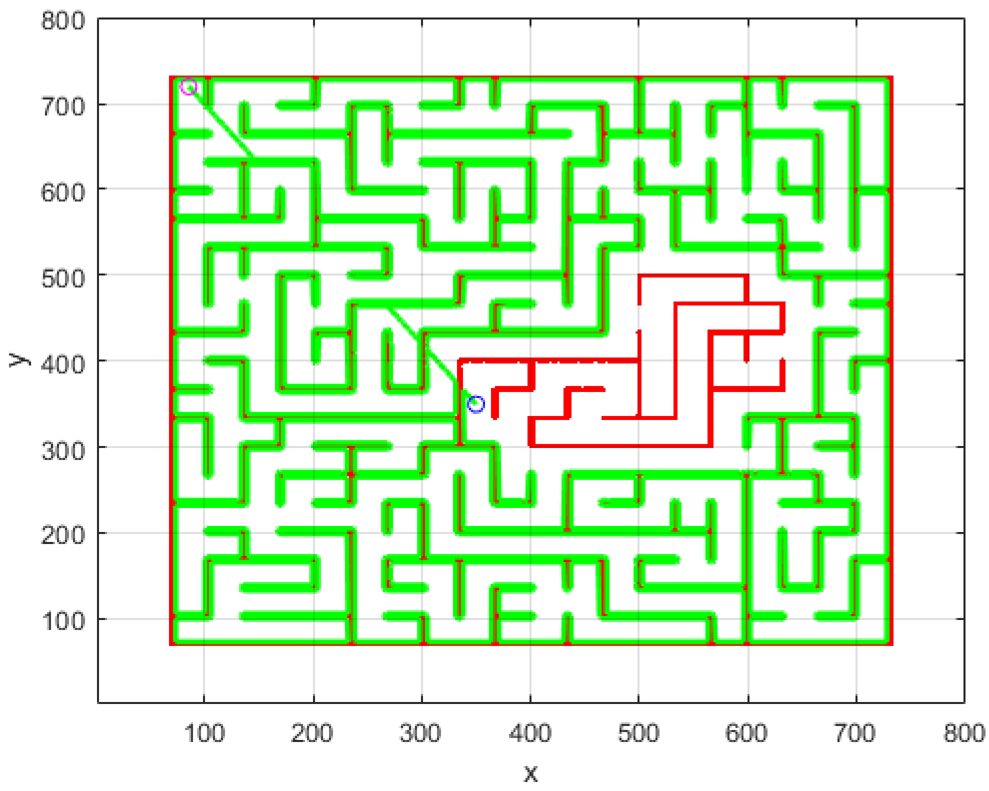

```
bug = Bug2(map);
bug.plot();
p = bug.query([50, 50], [20 20]);
hold on
plot(p(:, 1), p(:, 2), 'g', 'LineWidth',2)
```



b) Create an obstacle map that contains a maze. Can bug2 solve the maze?

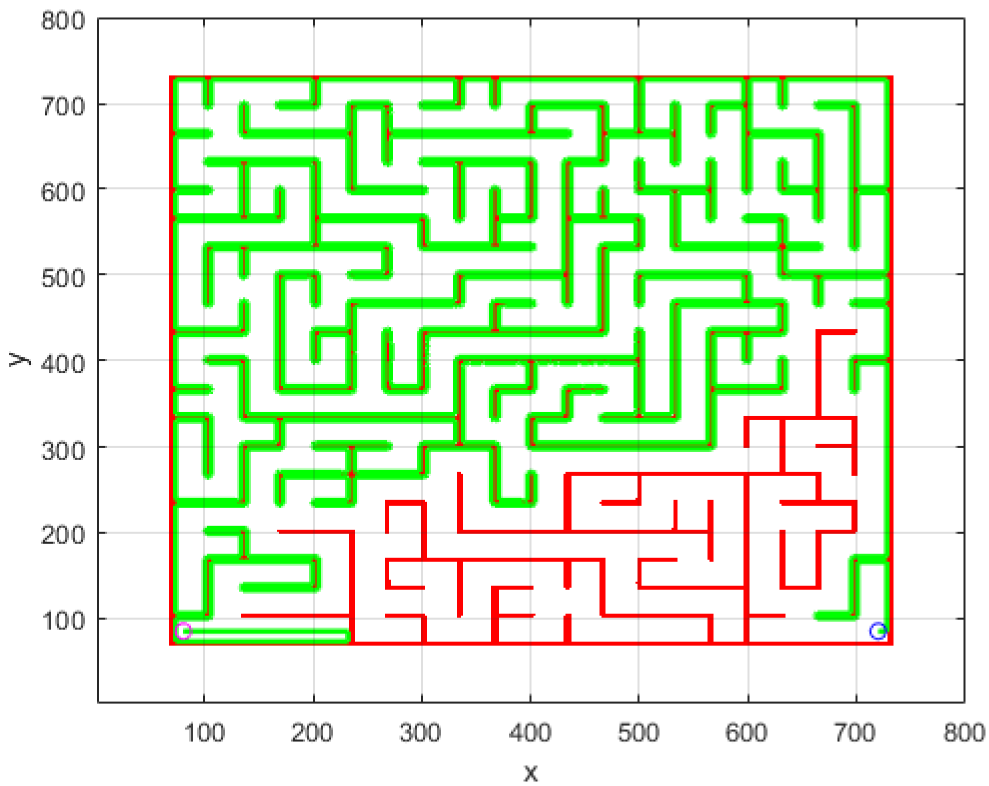
As we can see en the following figure, Bug2 can solve the maze.

```
clear
close all
clf

% Read the maze
map = imread('maze.jpg');
% Binarize the image
map = rgb2gray(map);
% Establish the walls
map = int8(map < 100);
% Remove the exits/entring of the maze
map(68:72, 68:733) = 1;
map(68:733, 68:72) = 1;

bug = Bug2(map);
bug.plot();
hold on
start = [85, 720];
goal = [350, 350];
p = bug.query(start, goal);
plot(p(:, 1), p(:, 2), 'g', 'LineWidth',2)
scatter(start(1), start(2), 'm');
scatter(goal(1), goal(2), 'b');
```



c) Experiment with different start and goal locations.

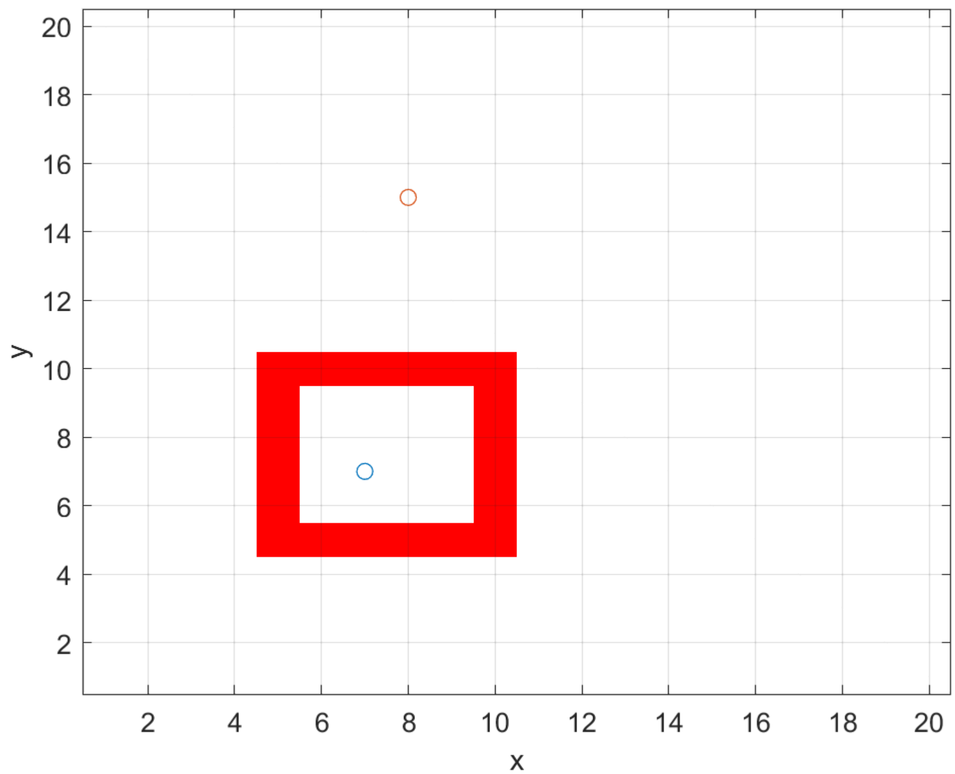
```
bug = Bug2(map);
bug.plot();
hold on
start = [80, 85];
goal = [720, 85];
p = bug.query(start, goal);
plot(p(:, 1), p(:, 2), 'g', 'LineWidth',2)
scatter(start(1), start(2), 'm');
scatter(goal(1), goal(2), 'b');
```



d) Create a bug trap. Make a hollow box, and start the bug inside a box with the goal outside. What happens?

The execution throw us an error confirming that could not reach the goal.

```
clear
close all
clf

map = zeros(20);
map(5:10, 5) = 1;
map(5:10, 10) = 1;
map(5, 5:10) = 1;
map(10, 5:10) = 1;
bug = Bug2(map);
bug.plot();
hold on
start = [7, 7];
goal = [8, 15];
scatter(start(1), start(2))
scatter(goal(1), goal(2))
```




```
p = bug.query(start, goal);
```

```
Error using Navigation/checkquery
Too many output arguments.
```

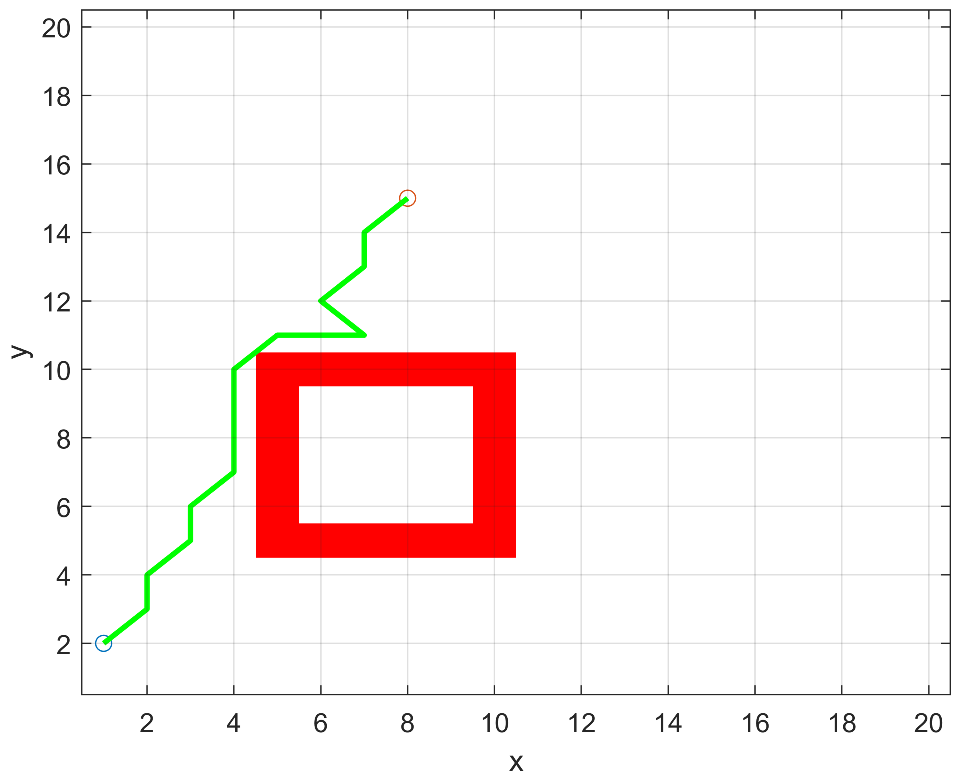
e) Modify bug2 to change the direction it turns when it hits an obstacle.

I created a new Bug2 file and added into this the following propertie and method:

```
    properties(Access=protected)
        H         % hit points
        j         % number of hit points
        mline     % line from starting position to goal
        step      % state, in step 1 or step 2 of algorithm
        edge      % edge list
        k         % edge index
        myDirection  % Dirreccion del movimiento 0 Left 1 Right
    end

    methods

        function bug = Bug2_mod(varargin)
            %Bug2.Bug2 Construct a Bug2 navigation object
            %
            % B = Bug2(MAP, OPTIONS) is a bug2 navigation object, and MAP is an occupancy grid,
            % a representation of a planar world as a matrix whose elements are 0 (free
            % space) or 1 (occupied).
            %
            % Options::
            % 'goal',G      Specify the goal point (1x2)
            % 'inflate',K   Inflate all obstacles by K cells.
            %
            % See also Navigation.Navigation.

            % invoke the superclass constructor
            bug = bug@Navigation(varargin{:});

            bug.H = [];
            bug.j = 1;
            bug.step = 1;
            bug.myDirection = 1;
        end

        function setMyDirection(bug, val, varargin)
            if val == 0
                bug.myDirection = 0;
            else
                bug.myDirection = 1;
            end
        end
```

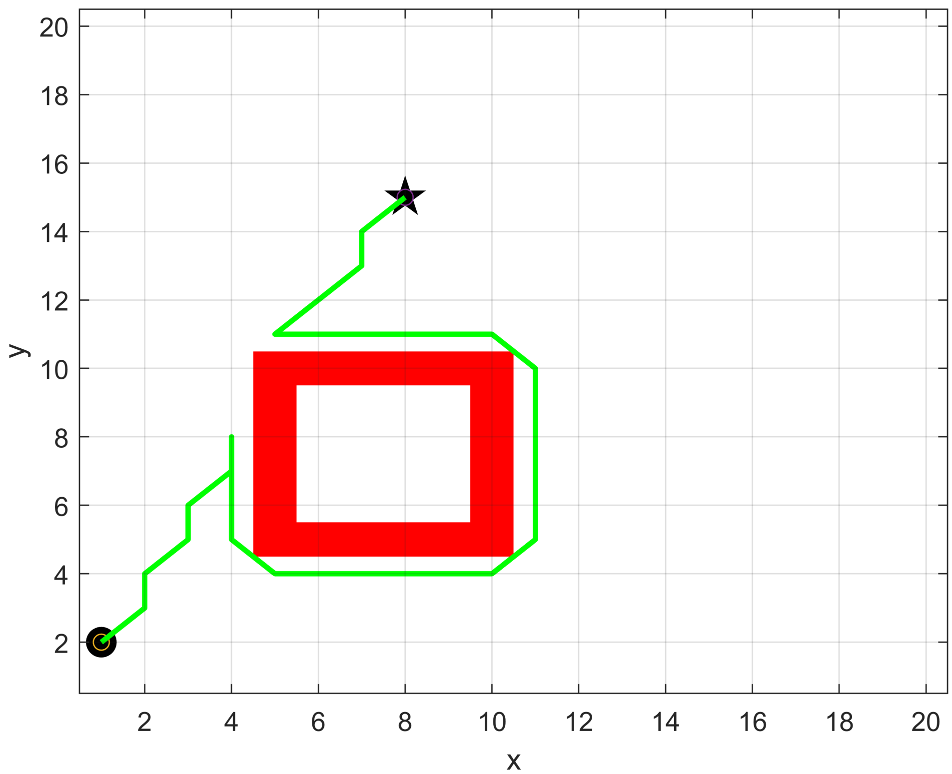
```
clear
close all
clf

map = zeros(20);
map(5:10, 5) = 1;
map(5:10, 10) = 1;
map(5, 5:10) = 1;
map(10, 5:10) = 1;
bug = Bug2_mod(map);
bug.plot();
hold on
start = [1, 2];
goal = [8, 15];
scatter(start(1), start(2))
```

```
scatter(goal(1), goal(2))
bug.setMyDirection(1);                    % Change to 0 to return the previous direction when fir
p = bug.query(start, goal);
plot(p(:, 1), p(:, 2), 'g', 'LineWidth', 2)
hold off
```



The original way that the bug takes when hits an obstacle.

```
bug.plot();
hold on
start = [1, 2];
goal = [8, 15];
scatter(start(1), start(2))
scatter(goal(1), goal(2))
bug.setMyDirection(0);                    % Change to 0 to return the previous direction when fir
p = bug.query(start, goal);
plot(p(:, 1), p(:, 2), 'g', 'LineWidth', 2)
```



20
18
16
14
12
10
8
6
4
2
y
2
4
6
8
10
12
14
16
18
20
x