HW03

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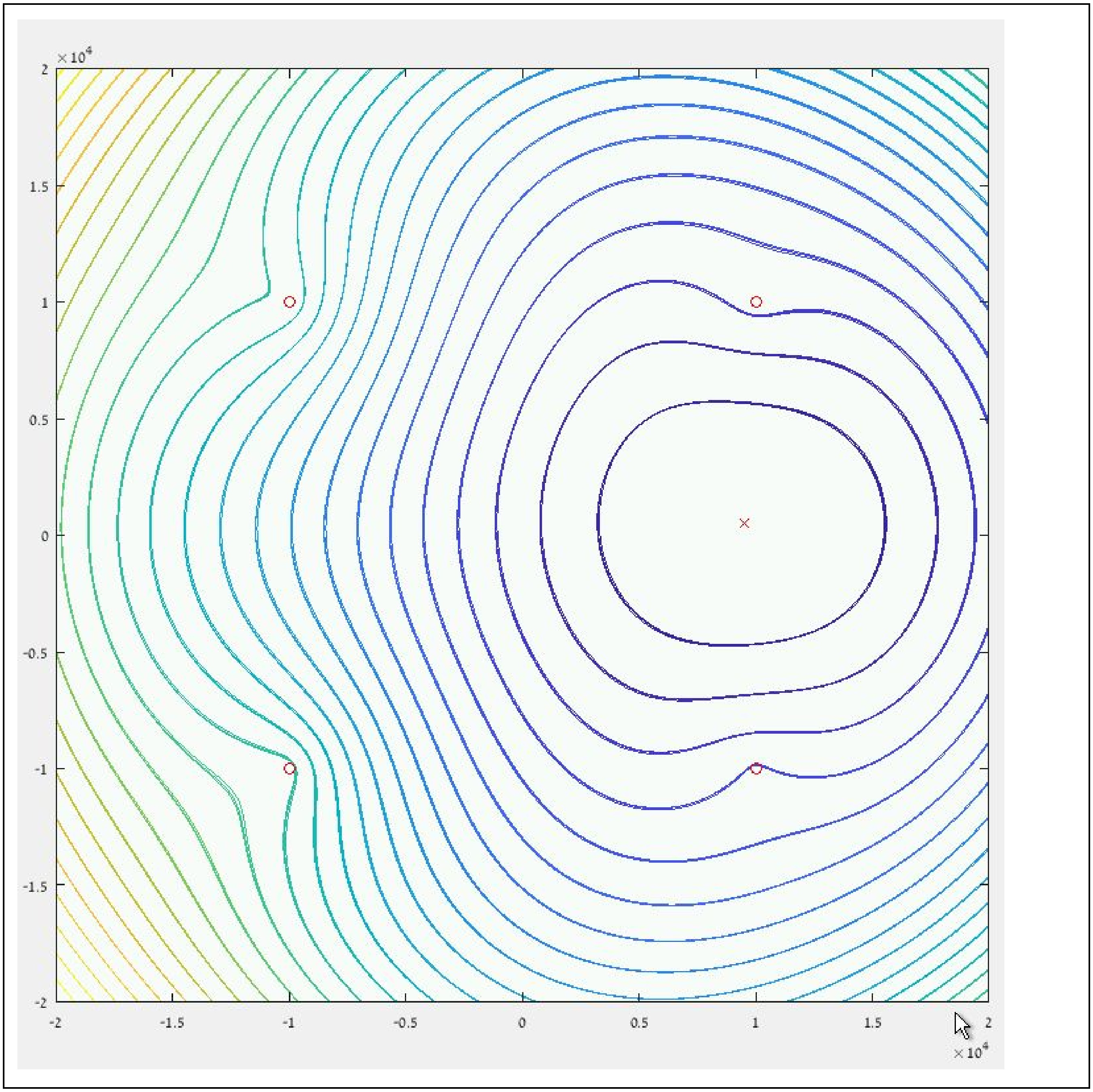
9.10.2

```
function [ m ] = trilateration_residual( controls, target_observations, location)
      m = dist(controls', location) - target_observations;
end
```

```
function [ m ] = trilateration_model( controls, location, error )
      m = dist(controls', location);
end
```

```
x = -20000:100:20000;
y = -20000:100:20000;

controls = [-10000,-10000; -10000, 10000; 10000, -10000; 10000, 10000]';
target = [9500, 500]';

phi_grid = zeros(length(x), length(y));
b = trilateration_model(controls, target);

for i=1:length(x)
      for j=1:length(y)
      r = trilateration_residual(controls, b, [x(i), y(j)]');
      phi_grid(i,j) = norm(r)^2;
      end
end
```



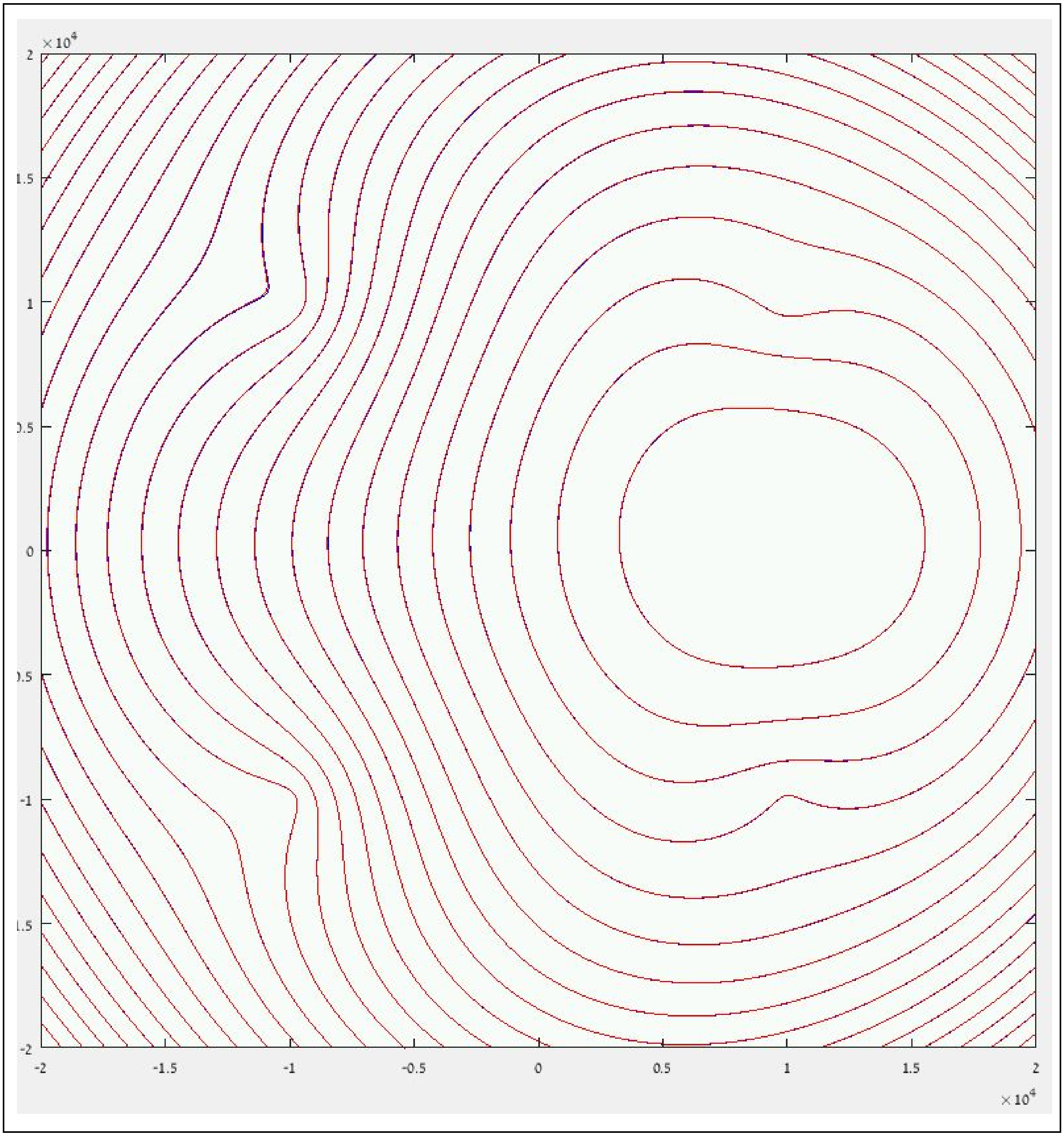
×10^4
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
×10^4

9.10.3

```
function [ m ] = trilateration_model( controls, location, error )
      func_error = 0;
      if nargin > 2
      func_error = error;
      end
      disp("error is: ");
      disp(func_error);
      m = dist(controls', location);
      for i=1:length(m)
      m(i) = m(i) + func_error*randn();
      end

end
```

```
>> contour(x,y,phi_grid',25, 'b');
>> daspect([1,1,1]);
>> hold on;
>> contour(x,y,phi_grid2',25, 'r');
```

We drew phi_grid2 (red) with the errors over phi_grid (blue) without the errors. If we look at the result we can see that in this resolution the error almost unseen.


× 10^4
2
1
0
-1
-2
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
× 10^4

9.10.5

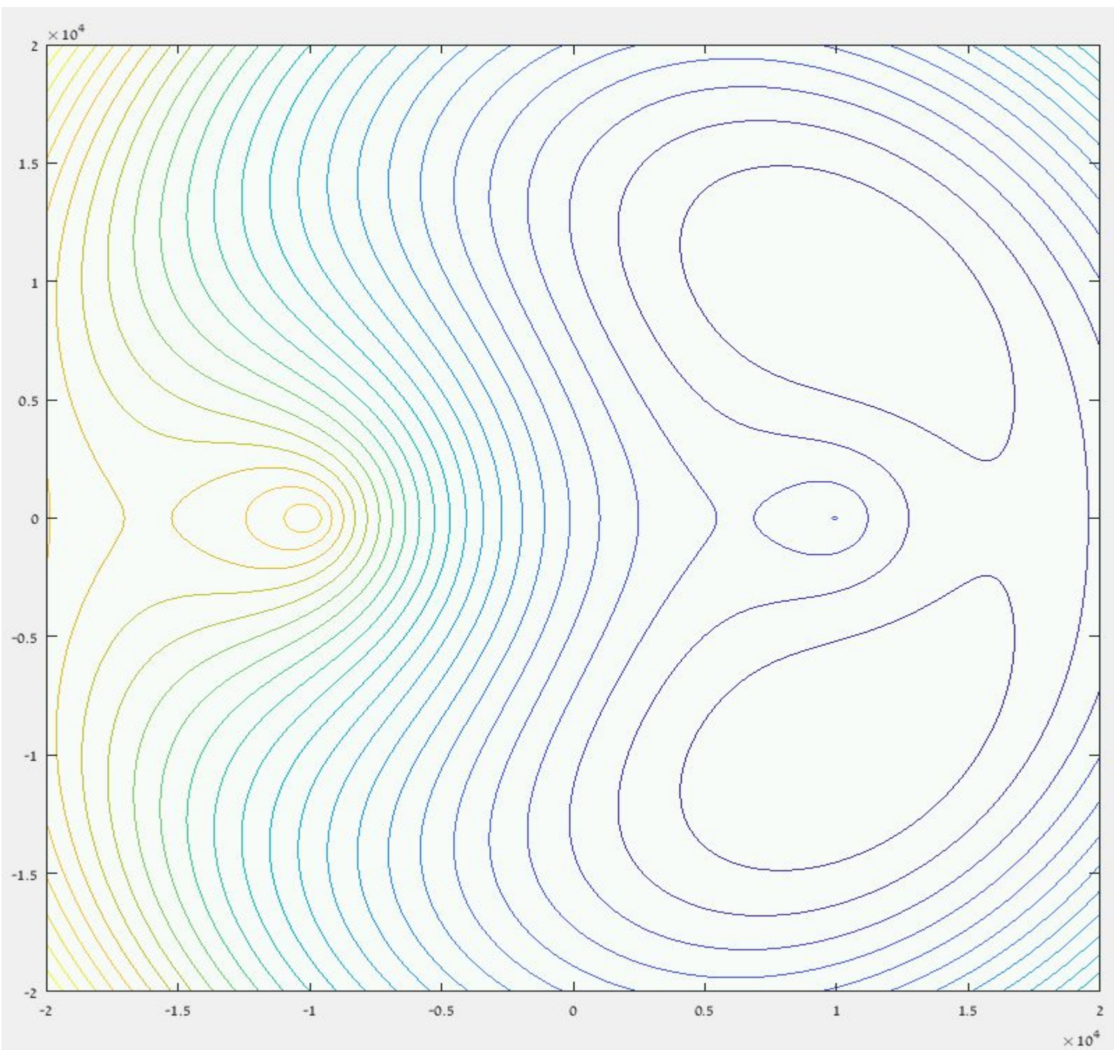
a.

If we choose the control points to mirror each other on the same line and the location is on on of the sides then we will get another point that is a minimum. For example:

controls = [10000,0; 9900, 0; -9900,0 ; -10000 , 0]';

target = [10000, 10000]';

We will get a minimum on (10000, 10000) and (-10000, 10000)

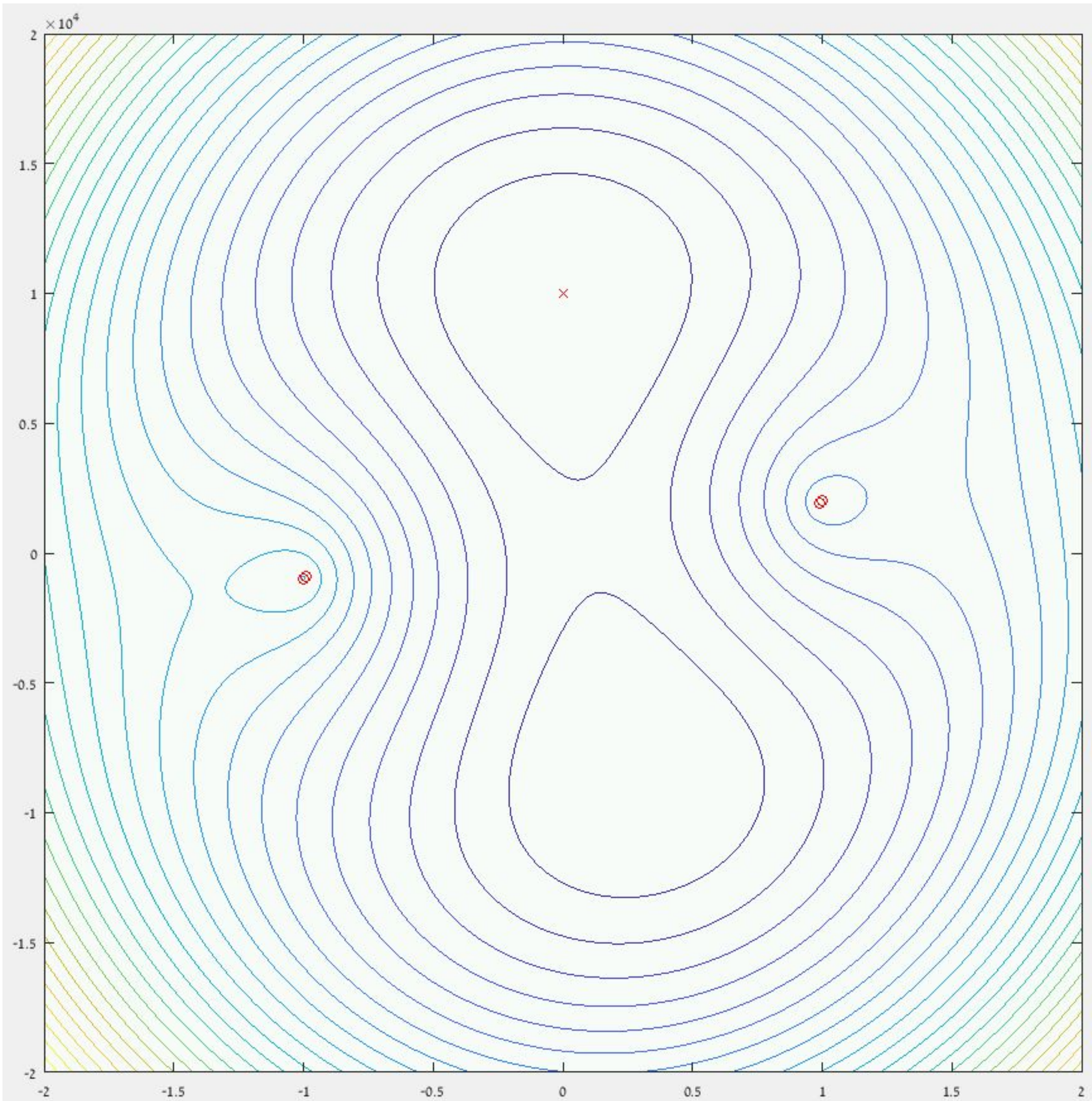


b.

If we put the control points on a diagonal that is not exactly symmetrical and we place the target between them we will get multiple minimum that only one is when phi=0
controls = [10000,2000; 9900, 1900; -9900,-900 ; -10000 , -1000]';
target = [0, 10000]';

```
syms x y;
p1x = 10000;
p1y = 2000;
p2x = 9900;
p2y = 1900;
p3x = -9900;
p3y = -900;
p4x = -10000;
p4y = -1000;
lx = 0;
ly = 10000;
f1 = ((p1x - x)^2 + (p1y - y)^2) - ((p1x - lx)^2 + (p1y - ly)^2);
f2 = ((p2x - x)^2 + (p2y - y)^2) - ((p2x - lx)^2 + (p2y - ly)^2);
f3 = ((p3x - x)^2 + (p3y - y)^2) - ((p3x - lx)^2 + (p3y - ly)^2);
f4 = ((p4x - x)^2 + (p4y - y)^2) - ((p4x - lx)^2 + (p4y - ly)^2);


n = f1^2 + f2^2 + f3^2 + f4^2;
gdnt = gradient(n);
gdnt_x = gdnt(1) == 0;
gdnt_y = gdnt(2) == 0;
S = solve([gdnt_x, gdnt_y], [x,y]);
vpa(S.x)
vpa(S.y)
```

```
ans =

     0

2711.6891268443708245752200526153

2332.9728512475743498973527879506
 - 1166.4345514432140630476664360082 -
10663.916455082970333479461384326i
 - 1166.4345514432140630476664360082 +
10663.916455082970333479461384326i


ans =

                                                              10000.0

-8604.3723629381729451611195599698

839.63663515328779091947134760822
 329.82577090189160713200648746218 -
1554.3163694041710818672473549119i
 329.82577090189160713200648746218 +
1554.3163694041710818672473549119i
```



$\times 10^4$
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2