

# ***TP Optimisation in Matlab***

## **1. Fitting an ellipse (2012)**

### 1. generalities

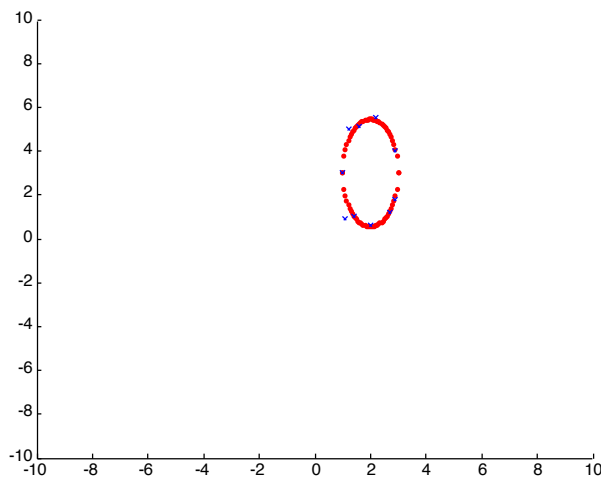
$$\frac{(x - x_c)^2}{a^2} + \frac{(y - y_c)^2}{b^2} = 1$$

The equation of an ellipse is

We dispose of 10 measure points.

```
datapts=[1 3;1.2 5; 1.6 5.1; 2.2 5.5;2.9 4;2.9 1.8;2.7 1.2;2  
0.6;1.4 1;1.1 0.9]
```

The following figure represents the ellipse supposed to be found in red and the measure points in blue.



Assume that these points should be on an ellipse, the goal for your algorithm is to find the best ellipse according to the set of points.

$x_c$ ,  $y_c$ ,  $a^2$ ,  $b^2$  are the parameters of the problem. They will be constitutive of the chromosomes.

The problem space is limited to  $[-5 \ 5]$  for the  $x_c$  value and for the  $y_c$  value, and is limited to  $[1 \ 16]$  for the parameters  $a^2$  and  $b^2$ .

The fitness function could take into account the sum of the distances between the points of the cloud and the ellipse with the current parameters. The best ellipse minimizes this sum of distance. The Euclidian distance can be chosen. There are other solutions.

Propose the Matlab program to solve this problem. Do not forget clear and useful comments in your program before sending it to me at the following e-mail: [eric.fauvet@u-bourgogne.fr](mailto:eric.fauvet@u-bourgogne.fr)

### 2. Orientation of the ellipse

We can now imagine the most general case where the axes of the ellipse are not parallel to the axis  $x$  and  $y$ . Propose a solution to solve that new problem.

### **3. Fitting a cloud of points with a function (2013-2014)**

I propose to fit a cloud of points with a known geometrical figure.

You can choose one of them in the following list:

- Catenoid
- Bohemian dome
- Egg box
- Dupin's cyclide
- Sea-shell
- Sinusoidal cone
- Circled helicoids
- Milk carton
- Other idea ...

What is expected ?

- The equation and the parameters of the curve are needed.
- You have to choose a cloud of points in the neighborhood of a curve with selected parameters (30 points will be a minimum). "It's to be able to verify the final result".
- And then with an optimization algorithm, you have to find the best parameters according to the cloud of points. (if the algorithm converge, it will give approximately the same value for the parameters).
  - Depending of your choices, you fix to the algorithm the limits of the parameters to limit the search space.
  - You can choose even genetic algorithm or simulated annealing for the optimization
  - The answer is the best solution found.

### **1. Fitting a 3D scan of an object with the reverse scan of this object (2015)**

- Goal: to obtain a new cloud of points by merging the 2 clouds.
- 1st difficulty: One is full for the second 10% of the points are missing.
- 2nd difficulty: for each cloud 10% of the points are missing
- 1st step: on a classical geometrical form
- 2nd step: on real scans

- Hint: creation of a geometrical form (Cylinder for example)
- You present your results next labwork schedule in a small powerpoint presentation (5-6 slides max)
- You send me an email with your program. Do not forget clear and useful comments in your program: [eric.fauvet@u-bourgogne.fr](mailto:eric.fauvet@u-bourgogne.fr)

See you next week with a solution ;)