	ADEO-M2 **TP : Simulated Annealing** *EISTI*	
	Subject : **AI and optimization**	*Due date* : **November 2, 2017**
		Number of pages : **3**

1 The travelling salesman probleme

Problem 1.

The Traveling Salesman Problem, TSP, is stated as follows :

"Given a list of cities and the distances separating each of them; what is the shortest possible tour that visits each city once and returns to the starting point?"

The objective is to find the shortest Hamiltonian cycle of the complete, undirected graph of cities. For 22 cities, there are more than 51.10^{18} tours possible, for 304 cities, more than 2.10^{624}! For a symmetrical path, the complexity is $\frac{(n+1)!}{2}$.

The archive `RS.tgz` contains all the files allowing to achieve this practical work. You will find a detailed description of its contents in the file`README.md`, as well as a set of problem instances to test your settings on a larger number of cities.

2 Understand the impact of settings

We will first run the algorithm at a fixed temperature, in order to study the behavior of this parameter.

Exercise 1.

a. Set a high temperature 10^6, interpret the behavior.

b. Set a temperature close to 0, interpret the behavior.

c. Studying a temperature value around which one goes from one behavior to another, interpret its value.

3 Performance measures

Exercise 2.

a. Display, at the end of the program, the number of improvements made during the execution of the algorithm as well as the report (improvement / number of evaluations).

b. What would be the performance criteria of the algorithm to compare 2 versions?

c. How to know if the result is correct or if the algorithm is stable?

4 Temperature

We will then run the algorithm at variable temperature, to study the behavior of this parameter..

Exercise 3.

a. Set a high temperature 10^6, interpret the behavior.

b. Set a temperature close to 0, interpret the behavior.

c. Set a growth value to $0.1, 0.5, 0.8, 0.9$ and 0.99, interpret the behavior.

d. By varying its value, study the impact of the tempera- ture plateau on the result of the algorithm.

e. Study the difference between the two equations of temperature.

5 Initialization and Neighborhood

Exercise 4.

a. Is it wise to initialize the solution as realized? What is the impact of an initialization at random?

b. The coded disturbance makes a modification of 4 edges. Perform a function that disrupts the solution of only 3 edges.

c. The 2-opt permutation realizes a disturbance that modifies only 2 edges. Test this permutation.

6 Convergence

Exercise 5.

a. Create a convergence criterion that stops (stops) the temperature step when there have been a number of iterations without improvement.

b. Create a convergence criterion that stops the algorithm when there are a number of iterations without improvement.

7 Continuous case

Problem 2.

The goal here is to emphasize the character **MÉTA**heuristic. We will therefore apply the simulated annealing algorithm on two continuous functions : Sphere[1] and Griewank[2]. Copy the file RSTSP.py in RSCONT.py, and modify it. Replace calls to the function `draw` by calls to the function `dispRes`.

Exercise 6.

The objective is to adapt the algorithm to solve the problem of minimization on Sphere and Griewank functions on the interval $[-600; 600]$.

a. Write both functions `sphere` and `griewank`.

b. Write the function `init` which returns a point initialized at random in the search space.

c. Rewrite function `fluctuation` who returns a neighbor from the current point. We will define a constant `STEP`, offset.

d. Launch the algorithm for each function in dimensions 4, 10 and 50 . Adapt the parameters to the convergence requirements..

[1] `http://www.sfu.ca/~ssurjano/spheref.html`

[2] `http://www.sfu.ca/~ssurjano/griewank.html`