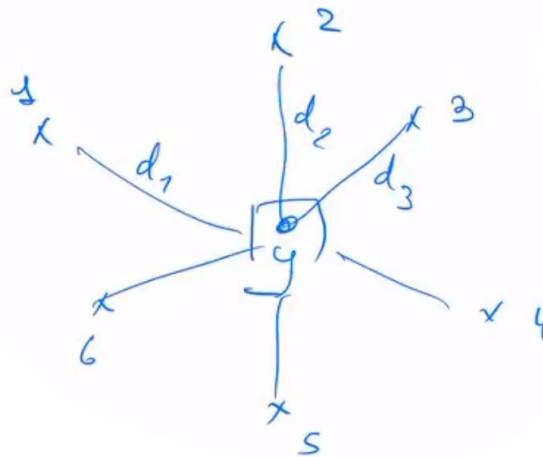


1 - Optimization problems and the search space

N persons in a 2D space who want to meet at some location y which minimizes the total distance travelled by all n persons. What is this point y ?

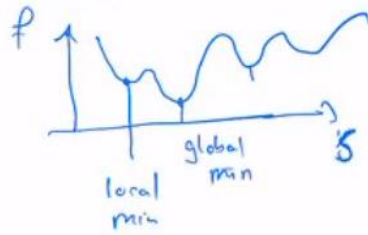


- The search space S , is a set of possible values for y
- If the problem is in $\mathbb{R}^2 \rightarrow$ the search space is \mathbb{R}^2 , all different possible values for y
- The search space can be continuous discrete finite or infinite
- If the search space is too big, we can't do an exhaustive search
- Let's define a function $f: S \rightarrow \mathbb{R}$, this function is called objective function, cost function, energy function, fitness function ..
- Its goal is to quantify a possible value y of the search space S , this way we can compare 2 different possible values for y and choose the best one. The main goal being to find the best value possible for y .
- This optimal value will either minimize or maximize the function f

$$\left\{ \begin{array}{l} x_{\text{opt}} = \underset{x \in S}{\operatorname{argmin}} / \underset{x \in S}{\operatorname{argmax}} f(x) \\ f_{\text{opt}} = \min / \max_{x \in S} f(x) = f(x_{\text{opt}}) \end{array} \right.$$

- This x_{opt} may not be unique

- One difficulty for these problems will be to distinguish global optimums from local optimums, visually it looks like this:



- Usually we deal with multidimensional problems:

$$x \in S \quad x = (x_1, x_2, \dots, x_n) \quad \begin{array}{l} \text{component of } x \\ \text{this is a vector} \end{array}$$

Here n is called the problem size

This is the number of degree of freedom in the problem.

S

metaheuristics is the way to explore S when no polynomial algorithms exist to find the optimal solution