6 - NK-problems: motivation, definition, goal

Inspired by biological problems -> genetic regulatory networks

NK problems belong to np-hard class !

Lets give an example of nk landscape problems:

- ➔ We consider N persons or agents, labelled with an index i, i = 1, . . ., N
- ➔ Each agent i acts according to two possible strategies, denoted xi = 0 or xi = 1
- ➔ The success of an agent depends on the strategy it chooses and the type of relation it has (competition or collaboration) with the other persons it interacts with
- ➔ If we assume that each agent i depends on K other agents, we may define a function fi(x i, ..., x i+k) which gives the profit resulting from the chosen strategy and that of the connected agents

The problem is specified once the f_i are given, as well as K, N

We want to maximize

$$f = \sum_{i=1}^{N} f_i$$ the profit of the population.

Our main interest with NK-problems is to be able to generate synthetic problems of increasing difficulty. (as N and k increase, it become more and more difficult to solve)

Example MaxOne problem.

Find a chain of N bits that maximize the number of ones.

Obvious solution: $X = (x_1 x_2 \dots x_N) = \underbrace{111\dots1}_{N \text{ times}}$

$f_i(x_i, \dots) = x_i \quad K = 1$

$$f = \sum_{i=1}^{n} f_i = \sum_{i=1}^{n} x_i$$

$f = N$

Another example

$x = x_1 x_2 \cdots x_N$ $\quad f_i(x_{i-1}, x_i, x_{i+1})$ $\quad K = 3$

f_i is max for 1 1 1 Then it is a trivial solut

Bl if f_i is large for 101 and small for 010

Then the chain 101010101