CIFO 24/03

NO WRITING AREA !

SIMULATED ANNEALING

- INITIALIZE (i, c, L)
- repeat until TERMINATION CONDITION:
  - repeat L TIMES:
    - TRANSITION (i, c)
  - UPDATE (c, L)
- RETURN THE BEST SO FAR

TRANSITION (i, c):
Generate a neighbor j of i;
ACCEPT_CRITERION (i, j, c)

ACCEPT_CRITERION (i, j, c):
if $f(j)$ BETTER OR EQUAL THAN $f(i)$
then $i := j$
else if rand $[0,1) < \exp\left(-\frac{|f(i) - f(j)|}{c}\right)$
then $i := j$

- INITIALIZATION OF i → TYPICALLY AT RANDOM
- INITIALIZATION OF c AND L → "LARGE"
- UPDATE c → DECREASE TENDING TO ZERO, WITHOUT EVER ARRIVING AT ZERO

THEOREM OF ASYMPTOTIC CONVERGENCE OF S.A.

GIVEN AN O.P. (S, f) AND GIVEN AN "APPROPRIATE" NEIGHBORHOOD, ASSUMING THAT c IS DECREASED TENDING TO ZERO WITHOUT REACHING ZERO

$$\lim_{\substack{c \to 0 \\ t \to \infty}} q_i(c) = \frac{1}{|S_{opt}|} \cdot g(i)$$

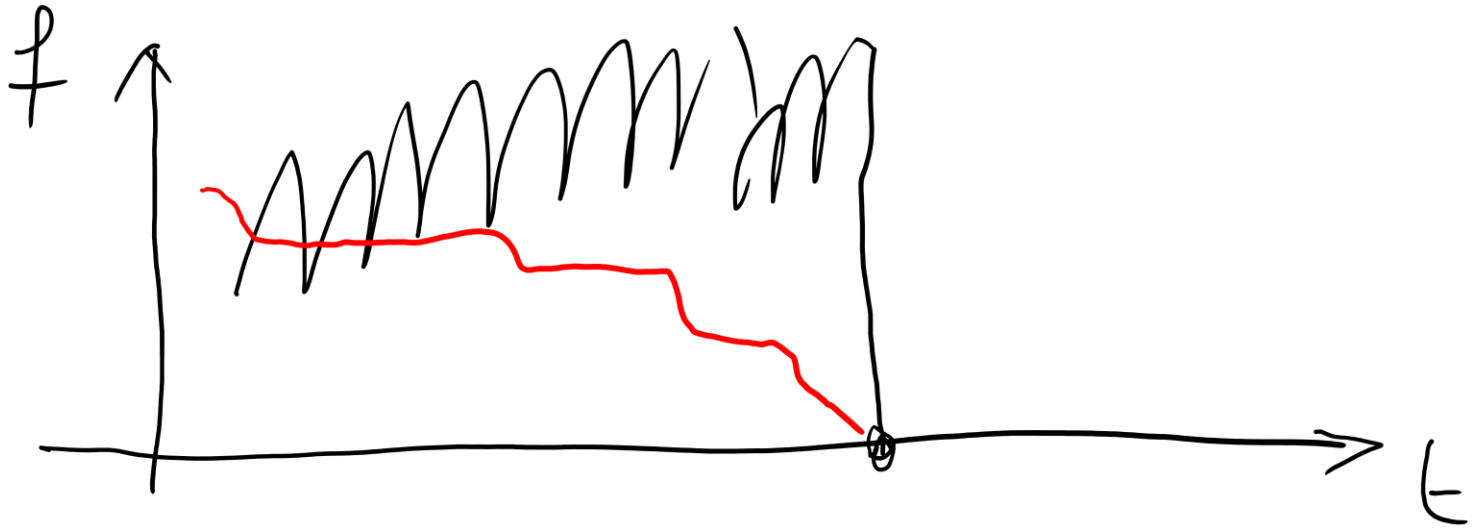
WHERE:

- $q_i(c)$ IS THE PROBAB. THAT THE S.A. WILL STABILIZE ON SOLUTION i USING CONTROL PARAMETER c
- S_{opt} = SET OF ALL EXISTING GLOBAL OPTIMA
- $$g(i) = \begin{cases} 1 & \text{if } i \in S_{opt} \\ 0 & \text{otherwise} \end{cases}$$

- THE S.A. TENDS ASYMPTOTICALLY TO STABILIZE ON A GLOBAL OPTIMUM (AND NOT ANY OTHER SOLUTION)

- THE PROBABILITY IS UNIFORMLY DISTRIBUTED AMONG ALL GLOBAL OPTIMA.

WHAT ABOUT THE "LAW OF BIG NUMBERS"



"APPROPRIATE" NEIGHBORHOOD

FOR ALL PAIRS OF SOLUTIONS i AND j, IT EXISTS A SEQUENCE OF SOLUTIONS

$$X_0, X_1, X_2, \ldots, X_m$$

SUCH THAT

- $\forall i = 1,2,..,m$ X_i IS NEIGHBOR OF X_{i-1}
- $X_0 = i$
- $X_m = j$

CONSEQUENCE OF THE THEOREM.

IN ORDER TO FIND A GLOBAL OPTIMUM IN ANY CASE :

- AN INFINITE NUMB. OF ITERATIONS WITH CONTROL PARAMETER c_0
- " " " " " " " " $c_1 < c_0$
- " " " " " " " " $c_2 < c_1$
- ...

INFINITE TIMES → LARGE

LARGE ↓

- LARGE NUMB. OF ITERATIONS
- LARGE L
- SLOW DECREASE OF c

} MAXIMIZES OUR PROB. OF FINDING A GLOB. OPT.

$$c = \frac{c}{k}$$

$k > 1$

$k \simeq 1,0001$

10100
00010

GENETIC ALGORITHMS

SIMILARLY TO S.A.

- EXPLORE THE SEARCH SPACE WITHOUT EVALUATING EXHAUSTIVELY ALL SOLUTIONS
- START FROM RANDOM SOLUTIONS AND IMPROVE THEIR QUALITY ITERATIVELY

DIFFERENTLY FROM S.A. :

- SOLUTIONS (INDIVIDUALS) MUST BE SEQUENCES OF A CONSTANT LENGTH
- THE SOLUTIONS THAT ARE MANAGED AT EACH ITERATION (GENERATION) ARE MORE THAN 1, WE TALK ABOUT A SET OF SOLUTIONS (POPULATION)
- BIOLOGICAL INSPIRATION : THEORY OF EVOLUTION OF C. DARWIN.

THEORY OF EVOLUTION OF DARWIN :

1. REPRODUCTION
2. ABILITY OF ADAPTION TO ENVIRONMENT
3. INHERITAGE
4. VARIATION
5. COMPETITION