CITO 24/02

Information:

3 MARCH ⟶ NO CLASS (CARNIVAL)

COMPENSATION:

SATURDAY, 8 MARCH, 11:00 - 12:30

ROOM: TO BE CONFIRMED

TO BE CONFIRM.

OPTIMIZATION PROBLEMS

(O.P.)

AN O.P. IS A PAIR (S, f) WHERE :

- S THE SET OF ALL SOLUTIONS, SEARCH SPACE
- $f: S \to \mathbb{R}$ FUNCTION THAT QUANTIFIES THE QUALITY OF SOLUTIONS, FITNESS FUNCTION.

AN O.P. CAN BE A MAXIMIZATION PB. IF ITS OBJECTIVE IS TO FIND A SOLUTION $x \in S$ SUCH THAT $\forall y \quad f(y) \leq f(x)$

MINIMIZATION

$\forall y \quad f(y) \geq f(x)$

X IS CALLED GLOBAL OPTIMUM

OPTIMIZATON ALGORITHM

AN ITERATIVE ALGORITHM THAT, AT EACH STEP, OUTPUTS A SOLUTION.

$$\vec{C} = [\, S_1, S_2, \dots S_m, \dots \,]$$

NO FREE LUNCH THEOREM (INFORMAL)

THE AVERAGE PERFORMANCE OF ALL EXISTING OPT. ALG. IS THE SAME IF EVALUATED OVER ALL POSSIBLE EXISTING O.P.

$P(\vec{C} \mid f, m, A)$ ← PROB. OF FINDING A GLOBAL OPTIMUM + TIME

CONSEQUENCES NFL

- IT CANNOT EXIST AN O.A. BETTER THAN ALL THE OTHERS ON ALL O.P. (SUPER-ALGORITHM)

- GIVEN A PARTICULAR PROBLEM, THERE CANNOT BE ANY FORMAL PROCESS TO DECIDE WHAT IS THE BEST ALGORITHM THE ONLY WAY TO DO THAT IS TO EXPERIMENTALLY COMPARE OR BY MEANS OF EXPERIENCE. (INFORMAL METHODS) (JUSTIFICATION FOR THE EXISTANCE OF SCIKIT LEARN, WEKA, ...)

- WE NEED TO KNOW MANY O.A. !

HILL CLIMBING

A WAY OF FINDING A SOLUTION IN A STEP-WISE REFINEMENT FASHION, TRYING TO IMPROVE FITNESS USING THE CONCEPT OF NEIGHBORHOOD

NEIGHBORHOOD

FUNCTION THAT, APPLIED TO ANY SOLUTION $x \in S$, RETURNS A SET OF SOLUTIONS $N(x)$ (NEIGHBORS OF x)

HILL CLIMBING

- INITIALIZE THE CURRENT SOLUTION x (TYPICALLY AT RANDOM)
- REPEAT
  - "GENERATE" A SOLUTION y FROM $N(x)$ → THE BEST OF $N(x)$
  - IF $f(y)$ IS BETTER OR EQUAL THAN $f(x)$ THEN $x := y$ (y BECOMES THE NEW CURR. SOL.)

UNTIL $\forall y \in N(x)$ $f(y)$ IS WORSE THAN $f(x)$

$\Downarrow$

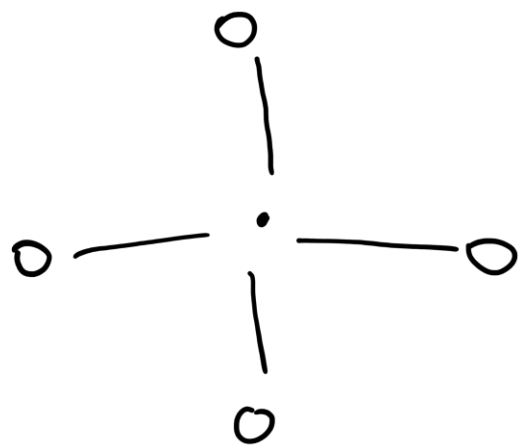
x IS A LOCAL OPTIMUM

EXAMPLE

FIND THE STUDENT IN THIS ROOM WITH THE MAX. STUDENT NUMBER

- $S = \{$ STUDENTS IN THIS ROOM $\}$
- $f(x) =$ STUDENT NUMBER OF x $\forall x \in S$
- MAXIMIZATION

- NEIGHBORHOOD



X = LEO

$f(x) = 0485$

$N(x) = \{$ PHIL, SVEN, ALEX $\}$

$f(\text{PHIL}) = 0518$, $f(\text{SVEN}) = 0503$, $f(\text{ALEX}) = 1599$

y = ALEX

X = ALEX

$X = ALEX$

$f(x) = 1599$

$N(x) = \{LEO, JULIA, SOPHIA, PEDRO\}$

$f(LEO) = 0485$

$f(JULIA) = 0574$

$f(SOPHIA) = 0654$

$f(PEDRO) = 0495$

$y = SOPHIA$

STOP

RETURN ALEX

DEF. (LOCAL OPTIMUM)

GIVEN AN O.P. (S, f) AND A NEIGHBORHOOD N
A LOCAL OPTIMUM IS A SOLUTION $x \in S$
SUCH THAT $\forall y \in N(x)$ $f(y)$ IS WORSE THAN $f(x)$

BY ITS VERY DEFINITION, THE H.C. ALWAYS RETURNS A LOCAL OPTIMUM, WITH NO GUARANTEE THAT THIS WILL ALSO BE A GLOBAL OPTIMUM.