

MOTIVATIONS...

Def. PROBLEM, ALGO

PROBLEM: TASK TO BE EXECUTED AUTOMATICALLY

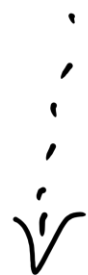
EXAMPLE: FIND THE MAX IN A
SEQ. OF NUMBERS

ALGORITHM: SEQUENCE OF PRECISE, FORMAL STEPS
THAT ALLOW TO SOLVE THE PROBLEM.

PROGRAM: TRANSLATION OF AN ALGORITHM
INTO A PROGRAMMING LANGUAGE

TRADITIONAL
COMPUTATIONAL
METHOD

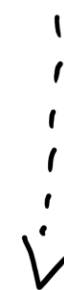
PROBLEM



PROBLEM
SOLVING

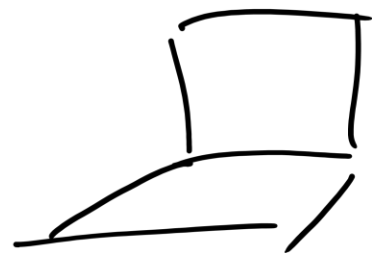
(CREATIVE)

ALGORITHM



IMPLEMENTATION

(FORMAL
AUTOMATIC)



MOTIVATION

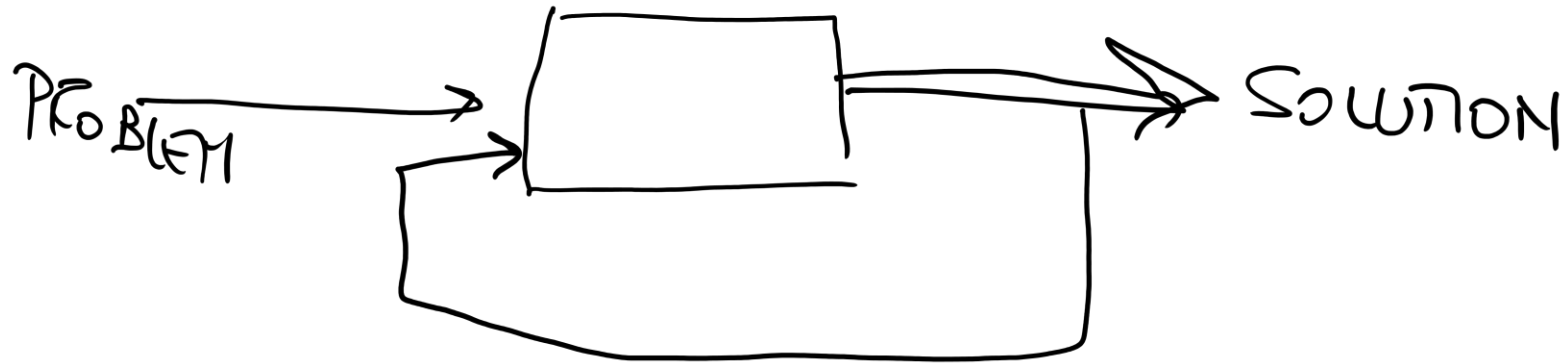
THE TRADITIONAL COMP. METHOD OFTEN FAILS BECAUSE
PROBLEMS EXIST FOR WHICH IT IS HARD OR
IMPOSSIBLE TO IMAGINE AN ALGORITHM
(COMPLEX PROBLEMS)

EXAMPLES

1. Client Categorization
2. Development of a new drug
3. Face recognition
4. Driving a robot in a 3D space
- ⋮

IDEA: GIVING COMPUTERS THE ABILITY TO LEARN
HOW TO SOLVE PROBLEMS
(MACHINE LEARNING, COMPUTATIONAL INT.)

LEARNING: IMPROVING BY MEANS OF EXPERIENCE



BIO-INSPIRED ALGORITHMS

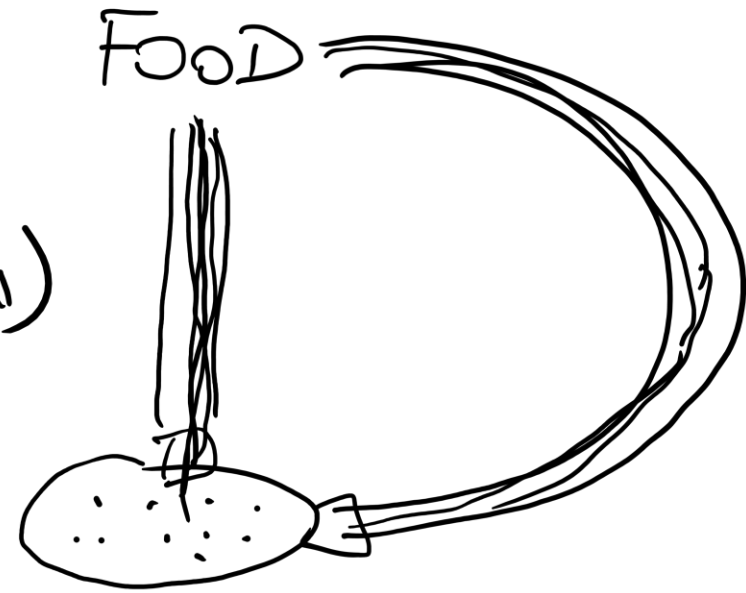
1) NEURAL NETS

2) EVOLUTIONARY ALGORITHMS
(GENETIC ALGORITHMS, GENETIC PROGRAMMING, ...)

3) FUZZY SYSTEMS

4) SWARM INTELLIGENCE
(PARTICLE SWARM OPTIMIZATION)

5) LOCAL SEARCH
(HILL CLIMBING, SIMULATED ANNEALING...)



OPTIMIZATION PROBLEMS (O.P.)

INFORMALLY

SOLVING AN O.P. MEANS TO FIND THE BEST SOLUTION(S) IN A (TYPICALLY HUGE) SET OF POSSIBLE ALTERNATIVES.

MORE FORMALLY

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

- S IS THE SET OF ALL EXISTING SOLUTIONS (SEARCH SPACE)
- $f: S \rightarrow \mathbb{R}$ RETURNS A NUMBER FOR EACH SOLUTION QUANTIFYING ITS QUALITY (FITNESS FUNCTION)

OBJECTIVE

FIND A SOLUTION $x \in S$ SUCH THAT

$\forall y \in S :$

$$f(y) \geq f(x) \quad (\text{MINIMIZATION PB.})$$

OR

$$f(y) \leq f(x) \quad (\text{MAXIMIZATION PB.})$$

SOLUTION x IS CALLED GLOBAL OPTIMUM.

OPTIMIZATION ALGORITHM

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

$$[\dots, s_1, s_2, s_3, \dots, s_m, \dots]$$

