Optimization Techniques

Laboratory 7

Genetics, evolution, and nature-inspired analogies
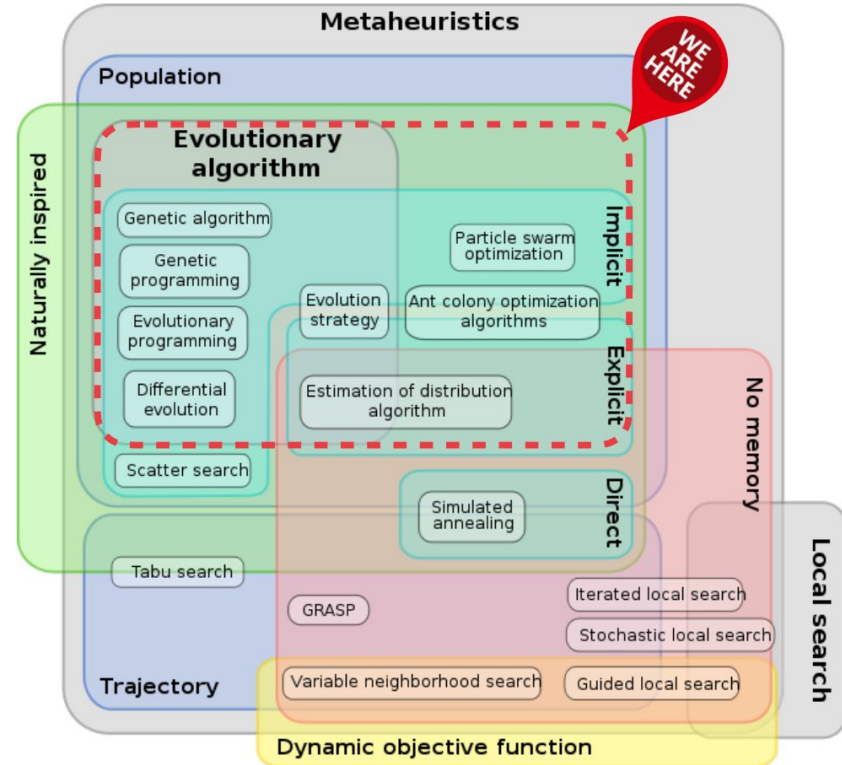
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Evolutionary Computation

- <u>Individual</u>
    Potential solution
    Has a fitness, measuring quality

- <u>Population</u>
    Set of individuals

- <u>Diversity</u>
    Measure of how different individuals are

- <u>Selection</u>
    Based on fitness

- <u>Inheritance</u>
    Partially transmit the properties of a
    solution to another

Evolutionary Computation

A GENERIC EVOLUTIONARY ALGORITHM FLOW

population

evaluation of fitness

parents selection

reproduction
(genetic operators)

offspring
(new individuals)

slaughtering/replacement

Swarm Intelligence

<u>Swarm Intelligence</u>
    Collective behaviour of
    simple agents with
    emergent intelligence

Challenges
- Find simple but sufficient
  behavioral rules
- Make emergent behavior
  stable

Particle Swarm Optimization

- A swarm of particles is initialized with random positions and velocity
- At each step, each particle updates first its velocity:

$$\overline{v}' = w \cdot \overline{v} + \phi_1 U_1 \cdot (\overline{y} - \overline{x}) + \phi_2 U_2 \cdot (\overline{z} - \overline{x})$$

where:
x and *v* are the particle's current position and velocity, respectively
z and *y* are the neighborhood and focal particle's best position, respectively
ω is the inertia (weighs the current velocity)
Φ_1 is the learning rate for the personal influence
Φ_2 is the learning rate for the social influence
U_1 and U_2 are uniform random numbers in [0,1]
- Then, each particle updates its position *x' = x+v'*
- In case of improvement, update **y** (and **z**)
- This loop is iterated until a given stop condition is met