Bio-inspired Algorithms in Grid

Presenter: Miguel Cárdenas Montes
CIEMAT

[1] V. Hernández, [1]G. Moltó.
[2] José M. Chaves-González, [3] Miguel A. Vega-Rodríguez, [3]Juan M. Sánchez-Pérez.
[3] Gabriel Neagu, Florin Pop, Valentin Cristea.
[4] A. Gómez-Iglesias, [2]Francisco Castejón Magaña, [2]Miguel Cárdenas-Montes.
[5] Francisco Herrera

[1]Universidad Politécnica de Valencia, [2]Universidad de Extremadura, [3]University "Politehnica" of Bucharest, [4]CIEMAT, [5]Universidad de Granada

Agenda Session

- **Agenda Session**
  - *General Introduction* (10').

Miguel Cárdenas-Montes.

  - *Grid-Based Metaheuristics Applied to Nuclear Fusion* (15').

Antonio Gómez-Iglesias.

  - *DIOGENES: Application Oriented Task Scheduling Using Genetic Algorithms* (15').

Florin Pop.

  - *Other works in bio-inspired strategies and grid* (10').

Miguel Cárdenas-Montes.

***Questions* (10').**

Authors/Institutions

- **Universidad Politécnica de Valencia**
  - Vicente Hernández, Germán Moltó.
- **Universidad de Extremadura**
  - Miguel A. Vega-Rodríguez, José M. Chaves-González, Juan M. Sánchez-Pérez.
- **University "Politehnica" of Bucharest,**
  - Gabriel Neagu, Florin Pop, Valentin Cristea.
- **CIEMAT**
  - Antonio Gómez Iglesias, Francisco Castejón Magaña, Miguel Cárdenas Montes.
- **Universidad de Granada**
  - Francisco Herrera.

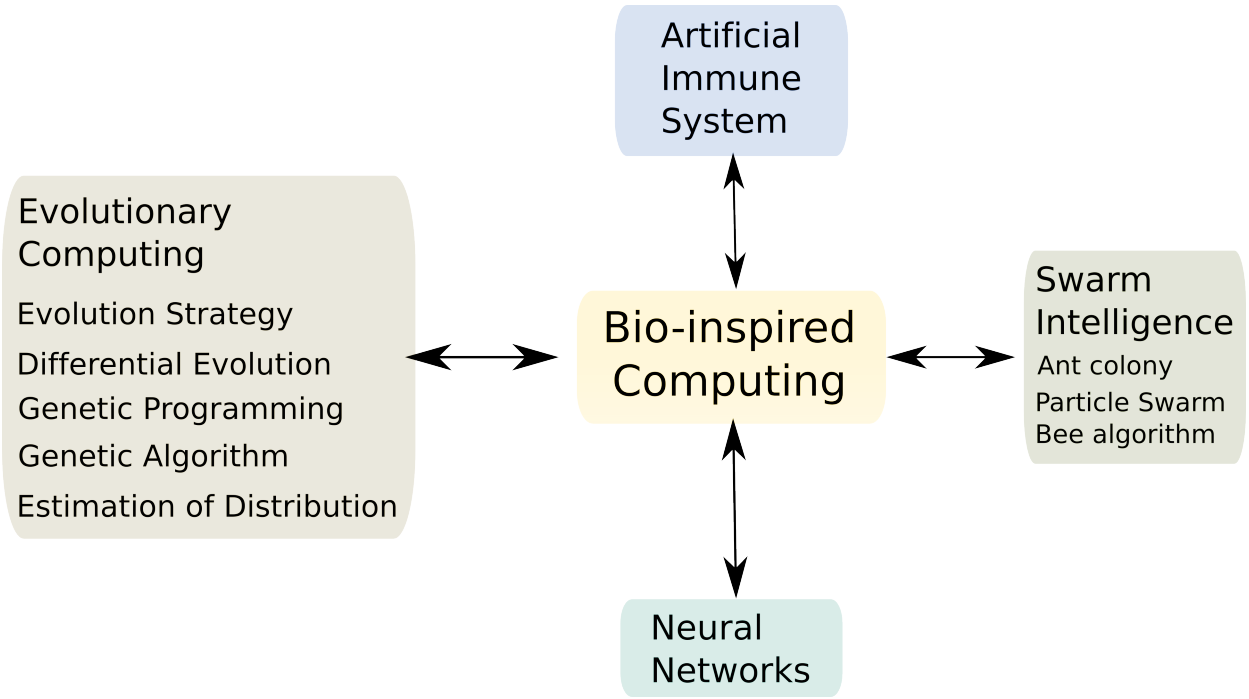
Outline

- Introduction.
- Bio-inspired Strategies. Taxonomies.
- Use in Science and Technology. Bio-inspired in Grid.
- Four Adaptation Models.

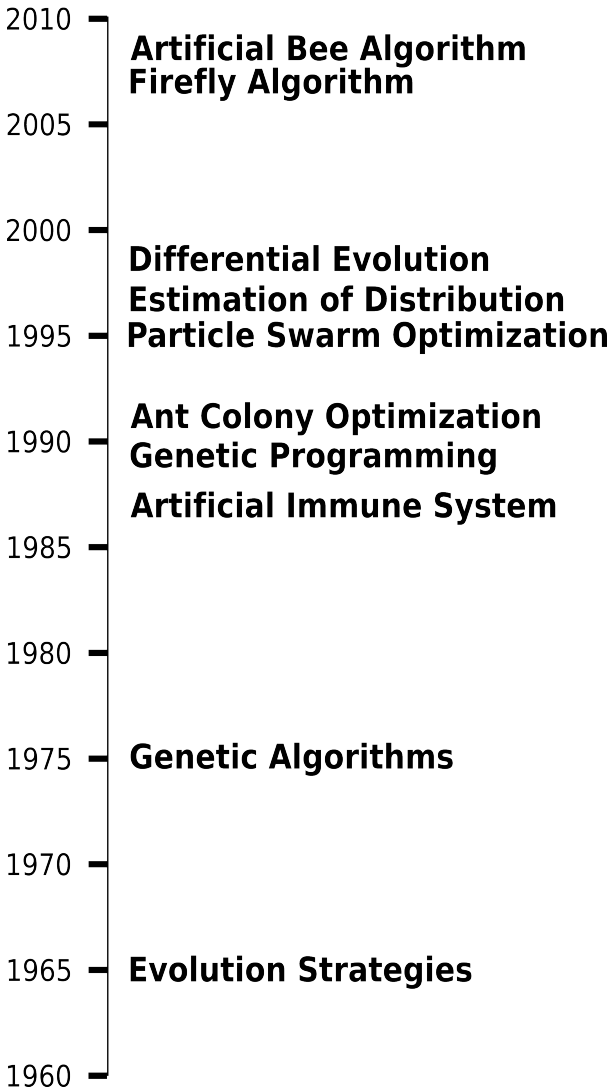
Bio-inspired Strategies I

- **Biologically inspired computing** is a field of **Soft Computing** (previously called **Artificial Intelligence**).
- Bio-inspired computing is a major subset of **Natural Computation**.
- It makes use of nature as inspiration for the development of problem solving techniques.
- Computing inspired by nature includes:
  - Evolutionary computation
  - Neural networks
  - Artificial immune systems
  - Swarm intelligence

Bio-inspired Strategies II



Chronogram



Scientific Problem

Scientific Problem

Bio-inspired Strategy

Computing Platform

- **Scientific or Technical Problems**
  - Wide portfolio of uses.
  - Optimization: search of minimum/maximum, or multi-objective.
  - Huge search space.
  - Complex problems.
  - Improve previous sub-optimal solutions.

Examples:

fusion, optics, telecommunication, grid application scheduling, chess, mathematics.

Bio-inspired Strategy

Scientific Problem

Bio-inspired Strategy

Computing Platform

- **Up to today.**
  - Not deeply exploited in grid.

- **Bio-inspired Strategy**
  - Wide portfolio of strategies.
  - Genetic Algorithms.
  - Multi-agents: ants, bees, swarms.
  - Neural Networks.
  - Some nice examples in EGEE.

Computing Platform

Scientific Problem

Bio-inspired Strategy

Computing Platform

- **In Grid.**
  - Reluctance of use grid. Other platforms most widely used: clusters, supercomputer, FPGU, GPU.
  - Suitable to hold bio-inspired algorithms.

- **Grid Computing.**
  - Four models of implementation.
  - Not the most frequent computing platform.
  - Excellent for tune production.
  - Excellent for large production.

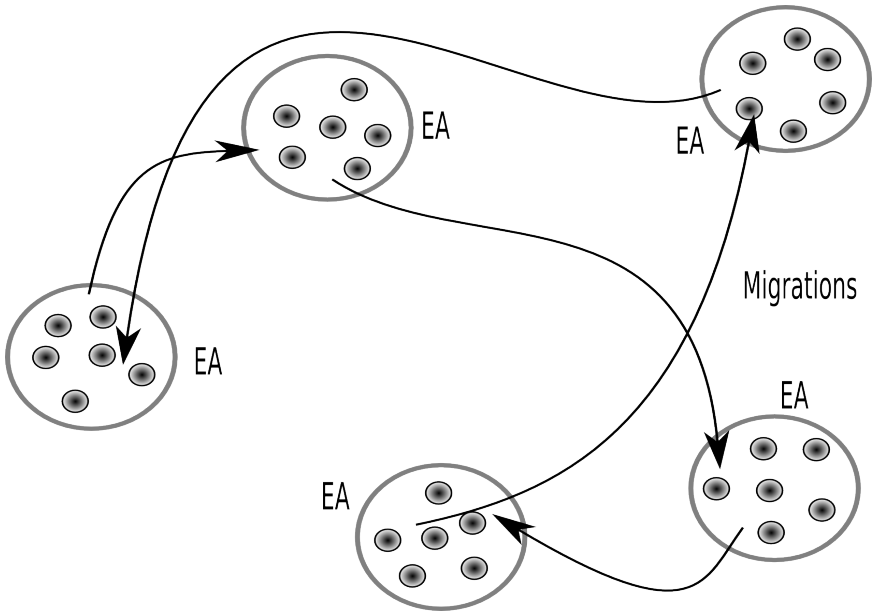
Four Adaptation Models I

- **Four Adaptation Models.**
  - N. Melab proposes three major parallel models for Evolutionary Algorithms.
  - Better understanding of the problem handled.
  - Useful for the porting process.
  - Models:
    - Island (a)synchronous cooperative model.
    - Parallel evaluation of the population.
    - Distributed evaluation of a single solution.
    - Independent island.

N. Melab et al. / J. Parallel Distrib. Comput. 66 (2006) 1052 – 1061

Four Adaptation Models II

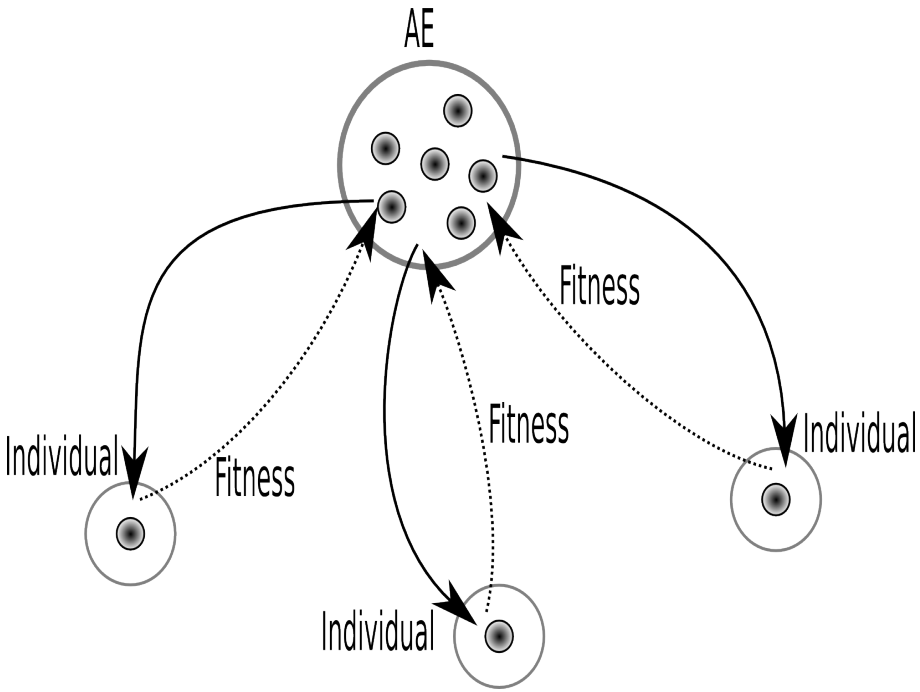
- **Island (a)synchronous cooperative model.**
  - Different EAs are simultaneously deployed to cooperate for computing better and more robust solutions.



- Larger population than single processor.
- Higher level of convergence.
- Best individuals guide the search.
- Manage the parallelisms: when and how interchange individuals?
- Waste of CPU-time in synchronous mode.

Four Adaptation Models III

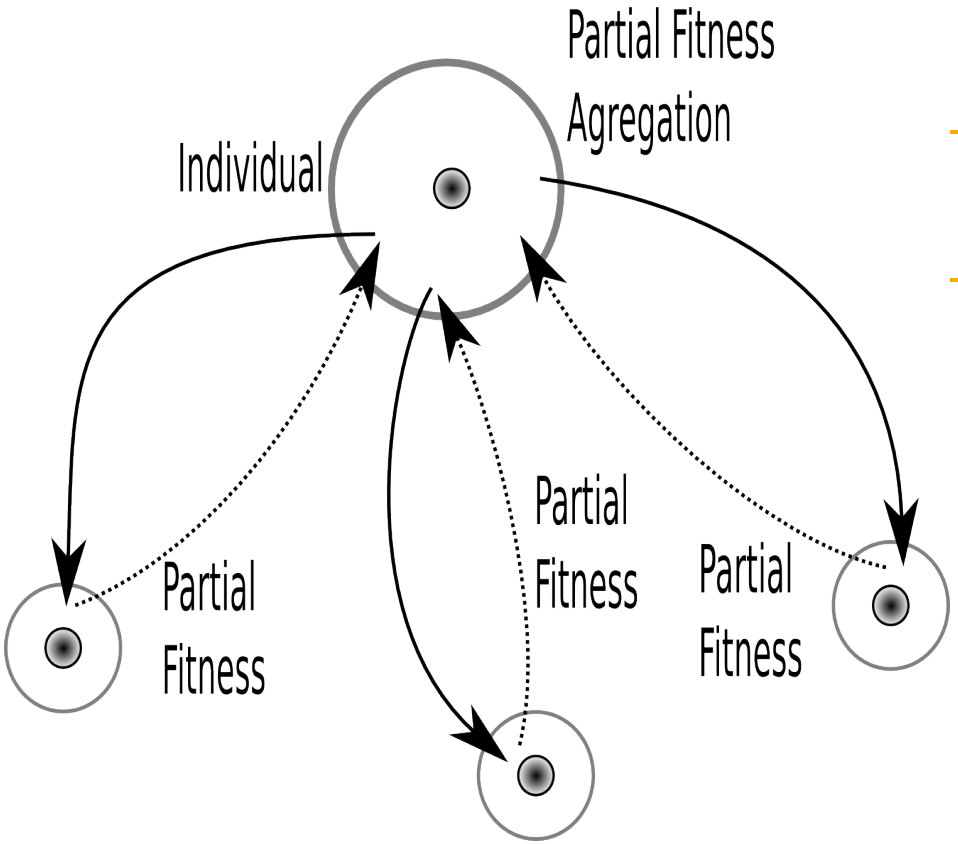
- **Parallel evaluation of the population.**
  - Suitable when the evaluation is the most time-consuming.
  - Master-Slave model



  - Speed-up of the overall process
  - Waste of CPU-time in synchronous mode

Four Adaptation Models IV

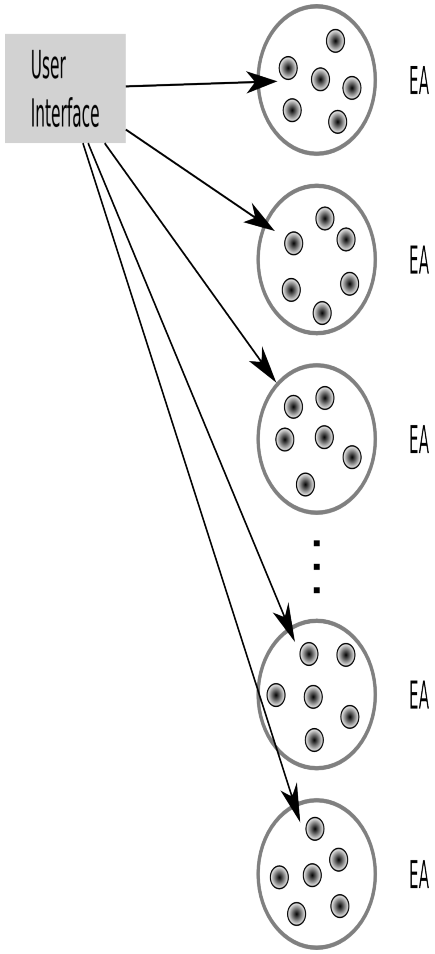
- **Distributed evaluation of a single solution.**
  - Suitable when the evaluation fitness function can be itself parallelized, being CPU time intensive.



  - Speed-up of the overall process
  - Waste of CPU-time if each part of the fitness function are very different in execution time

Four Adaptation Models V

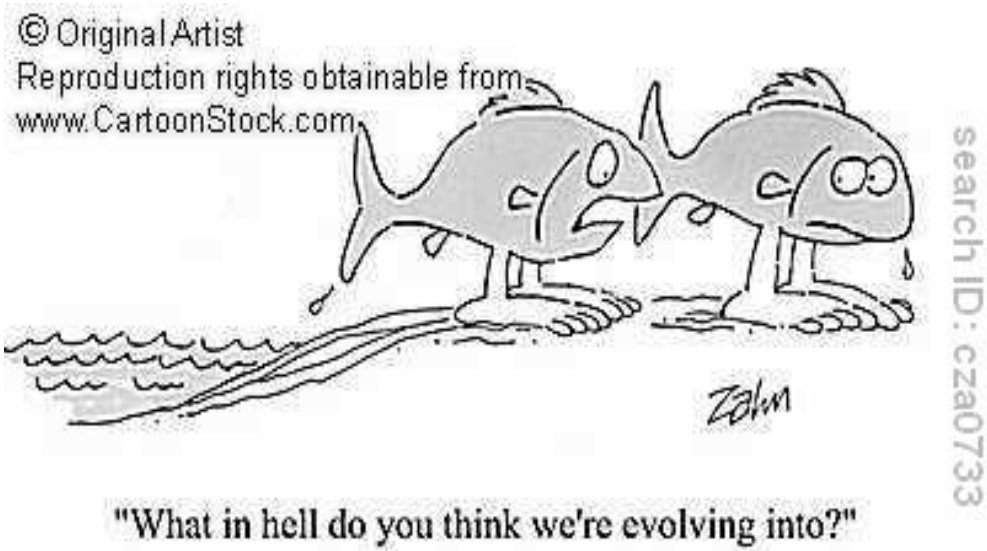
- **Independent island.**



- Larger population that single machine.
- Easy implementation in grid.
- Starting from scratch each job.
- Good individuals are not interchanged.
- Lower level of convergence than cooperative models.

Thanks

- **Thanks.**
- **Gracias.**
- **Merci.**



Now some nice examples ...