Natural Computing: Particle Swarm Optimization and Differential Evolution

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Natural Computing (NC) is the study of human-designed computing techniques inspired by nature as well as the computational processes taking place in nature.

Concepts and Models in NC

Self-organization
Swarm
Distinguish self from non-self
Artificial Immune System
Self-regulation
Feature extraction
Frequency Modulation
Neural Computation
Learning
Self-programming
Self-reproduction
Cellular Automata

Particle Swarm Optimization (PSO)

Biological Analogy

Inspired by the social behavior of swarms in nature. It simulates the collective behavior of individual agents interacting with one another and within the populace to learn from the environment in order to find a solution.

PSO

Developed by James Kennedy and Russel Eberhart in 1995.

Main Variants

Basic Variant of PSO
- Velocity Clamping
- Inertia Weight
- Constriction Coefficient
- Synchronous Vs Asynchronous

Modification Variant of PSO
- Single Solution of PSO
- Niching with PSO
- Constraint Optimization using PSO
- Multi-objective optimization
- Dynamic Environment of PSO
- Discrete PSO

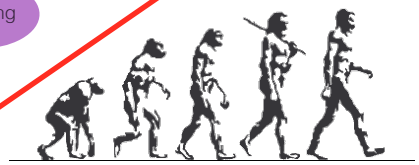
Applications

- Human Tremor
- Playing Games
- 3D to-3D Imaging
- Antenna Design

Differential Evolution (DE)

Biological Analogy

Inspired by Charles Darwin's theory of Evolution, where in every new generation offspring are produced that are more adapted to their environment and therefore more likely to survive.



In an artificial evolutionary environment each individual is represented as a point in a search space of potential solutions to a problem.

Developed by Rainer Storn and Kenneth Price in 1996.

DE

Main Variants

Each vector in the population undergoes DE's basic strategy as follows:

Initialization → Mutation → Recombination → Selection

The method of creating the mutant vector and the type of recombination operator applied demarcates the various DE schemes. ***DE/x/y/z*** is the notation used to classify them.

Applications

- Si-H Clusters
- Magnetic Bearings
- Computer Vision
- Erasure Codes

PSO and DE

- Metaheuristic algorithms
- Global Optimization methods
- Based on the dynamics of life
- Machine Intelligence
- Hybrids