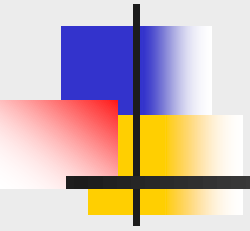


Evolutionary Algorithm

- Aspect & Prospect

Dr. Md. Aminul Haque Akhand
Dept. of CSE, KUET

Evolutionary Algorithm (EA) Basics

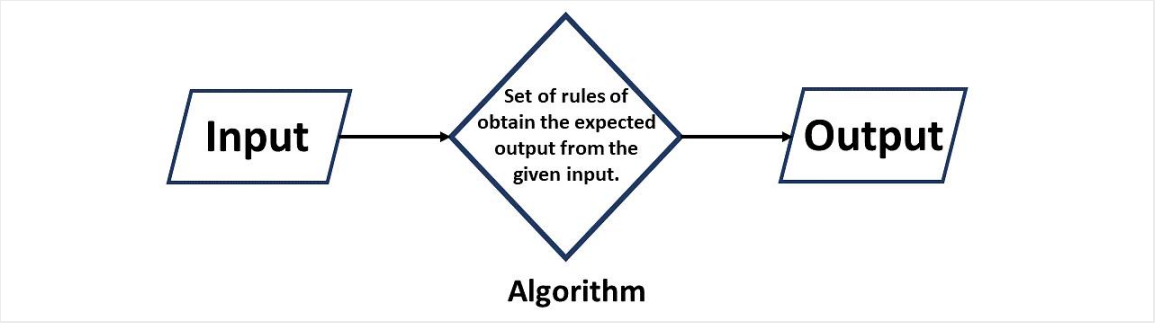
Evolutionary
(Search and Optimization)
Algorithm

Evolutionary Algorithm
for
Search and Optimization

An Evolutionary Algorithm
is a subset of
Evolutionary Computation

What is Algorithm?

- An algorithm is a set of commands that must be followed for a computer to perform calculations or other problem-solving operations.
- According to its formal definition, an algorithm is a finite set of instructions carried out in a specific order to perform a particular task.
- It is not the entire program or code; it is simple logic to a problem represented as an informal description in the form of a flowchart or pseudocode.



https://www.simplilearn.com/tutorials/data-structure-tutorial/what-is-an-algorithm#what_is_an_algorithm

What is Algorithm?

https://en.wikipedia.org/wiki/Algorithm

- In mathematics and computer science, an algorithm is a finite sequence of rigorous instructions, typically used to solve a class of specific problems or to perform a computation.

- Algorithms are used as specifications for performing calculations and data processing.

- By making use of artificial intelligence, algorithms can perform automated deductions (referred to as automated reasoning) and use mathematical and logical tests to divert the code execution through various routes (referred to as automated decision-making).

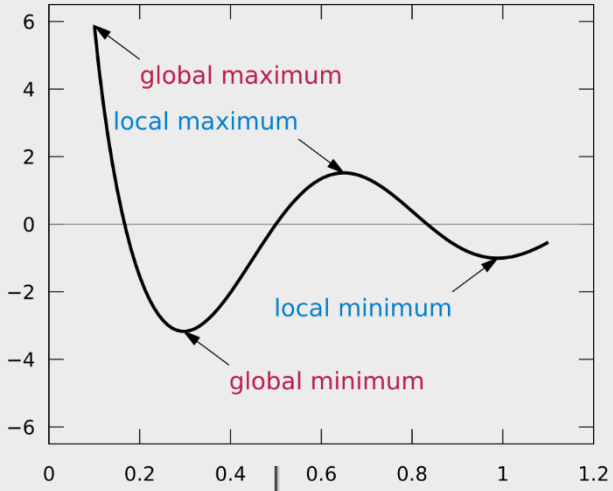
Task: Search and Optimization

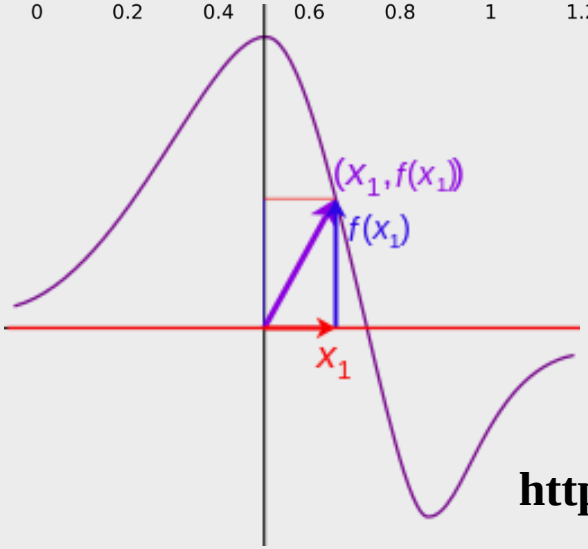
Search (General Definition)
https://www.dictionary.com/browse/search

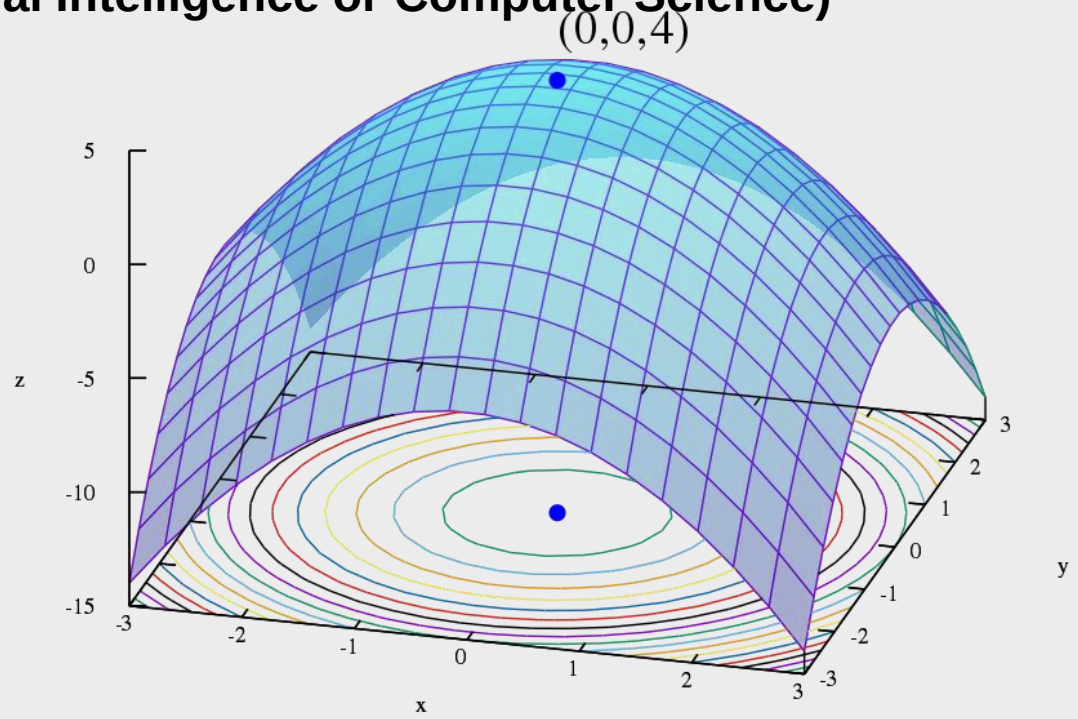
- to go or look through (a place, area, etc.) carefully in order to find something missing or lost: They searched the woods for the missing child. I searched the desk for the letter.
- to look at or examine (a person, object, etc.) carefully in order to find something concealed: The police searched the suspect for weapons.
- to explore or examine in order to discover: They searched the hills for gold.

Task: Search and Optimization

Search (Computational Intelligence or Computer Science)







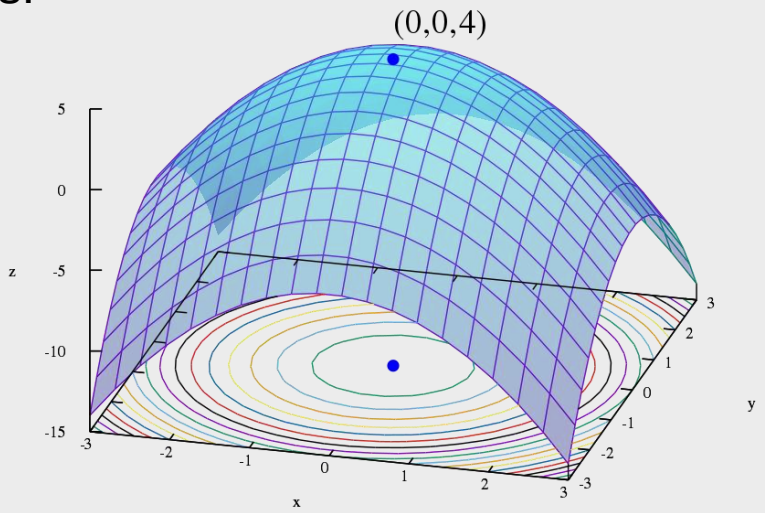
Graph of a given by $z = f(x, y) = -(x^2 + y^2) + 4$. The global maximum at $(x, y, z) = (0, 0, 4)$ is indicated by a blue dot.

https://en.wikipedia.org/wiki/Test_functions_for_optimization

Task: Search and Optimization

Optimization (General) https://www.dictionary.com/browse/optimization

- the fact of optimizing; making the best of anything.
- the condition of being optimized.
- Mathematics: A mathematical technique for finding a maximum or minimum value of a function of several variables subject to a set of constraints, as linear programming or systems analysis.

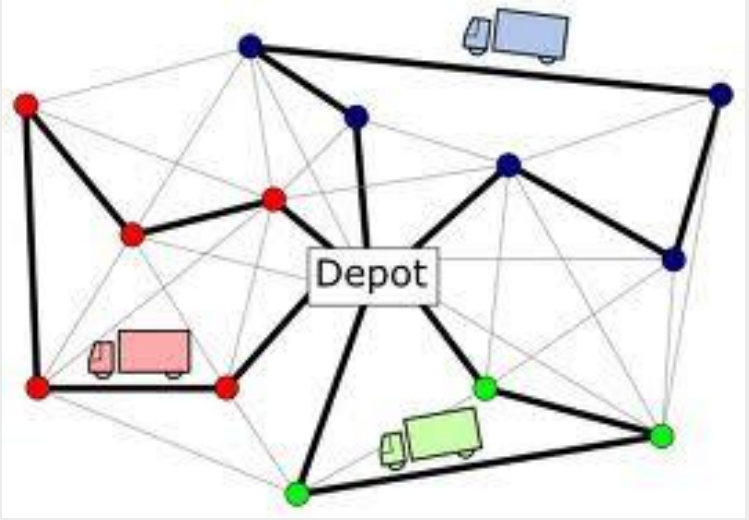


Task: Search and Optimization

Optimization (Computational Intelligence or Computer Science)

Traveling Salesman Problem (TSP)

Vehicle Routing Problem (VRP)



http://elib.zib.de/pub/mp-testdata/tsp/tsplib/tsplib.html

https://neo.lcc.uma.es/vrp/vrp-instances/capacitated-vrp-instances/

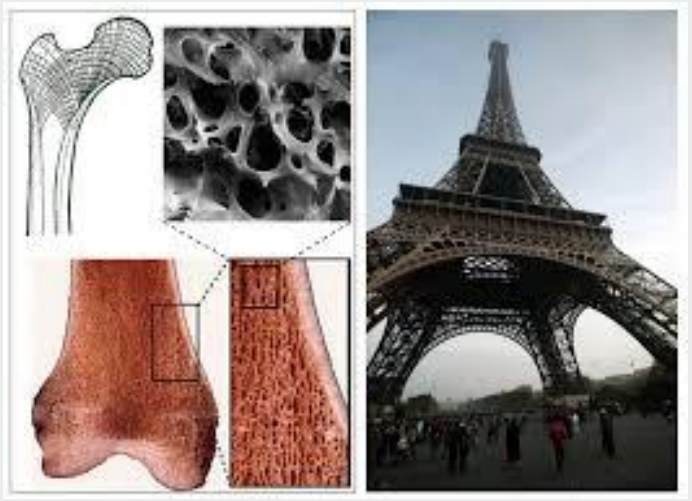
Task: Search and Optimization

Search and Optimization in Real-Life Scenarios

Solving Method: Evolutionary Approach

Techniques taking idea from Natural Phenomena

Biomimicry / Biomimetic: Technology is inspired by nature



Eiffel tower designed on the femur (the human thighbone)

https://biomimicry.org/examples/

The giant water lily that inspired the London Crystal Palace

https://www.youtube.com/watch?v=HppE6ezLDqI

Our Course Concern: Computing Techniques based on Natural Phenomena

Evolutionary Algorithm

https://en.wikipedia.org/wiki/Evolutionary_algorithm

In computational intelligence (CI), an evolutionary algorithm (EA) is a subset of evolutionary computation, a generic population-based metaheuristic optimization algorithm. An EA uses mechanisms inspired by biological evolution, such as reproduction, mutation, recombination, and selection.

Candidate solutions to the optimization problem play the role of individuals in a population, and the fitness function determines the quality of the solutions (see also loss function).

Evolution of the population then takes place after the repeated application of the above operators

Evolutionary algorithm

Artificial development · Artificial life · Cellular evolutionary algorithm · Cultural algorithm · Differential evolution · Effective fitness · Evolutionary computation · Evolution strategy · Gaussian adaptation · Evolutionary multimodal optimization · Particle swarm optimization · Memetic algorithm · Natural evolution strategy · Neuroevolution · Promoter based genetic algorithm · Spiral optimization algorithm · Self-modifying code · Polymorphic code

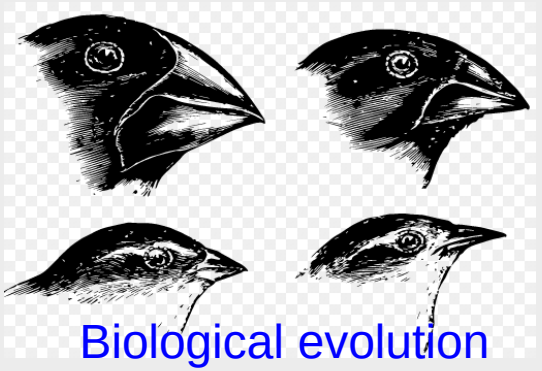
Genetic algorithm

Chromosome · Clonal selection algorithm · Crossover · Mutation · Genetic memory · Genetic fuzzy systems · Selection · Fly algorithm

Evolutionary Computation

https://en.wikipedia.org/wiki/Evolutionary_computation

In computer science, evolutionary computation is a family of algorithms for global optimization inspired by biological evolution, and the subfield of artificial intelligence and soft computing studying these algorithms. In technical terms, they are a family of population-based trial and error problem solvers with a metaheuristic or stochastic optimization character.



Biological evolution

In evolutionary computation, an initial set of candidate solutions is generated and iteratively updated. Each new generation is produced by stochastically removing less desired solutions, and introducing small random changes. In biological terminology, a population of solutions is subjected to natural selection (or artificial selection) and mutation. As a result, the population will gradually evolve to increase in fitness, in this case the chosen fitness function of the algorithm.

Evolutionary computation techniques can produce highly optimized solutions in a wide range of problem settings, making them popular in computer science. Many variants and extensions exist, suited to more specific families of problems and data structures.

Evolutionary algorithm

Artificial development · Artificial life · Cellular evolutionary algorithm · Cultural algorithm · Differential evolution · Effective fitness · Evolutionary computation · Evolution strategy · Gaussian adaptation · Evolutionary multimodal optimization · Particle swarm optimization · Memetic algorithm · Natural evolution strategy · Neuroevolution · Promoter based genetic algorithm · Spiral optimization algorithm · Self-modifying code · Polymorphic code

Genetic algorithm

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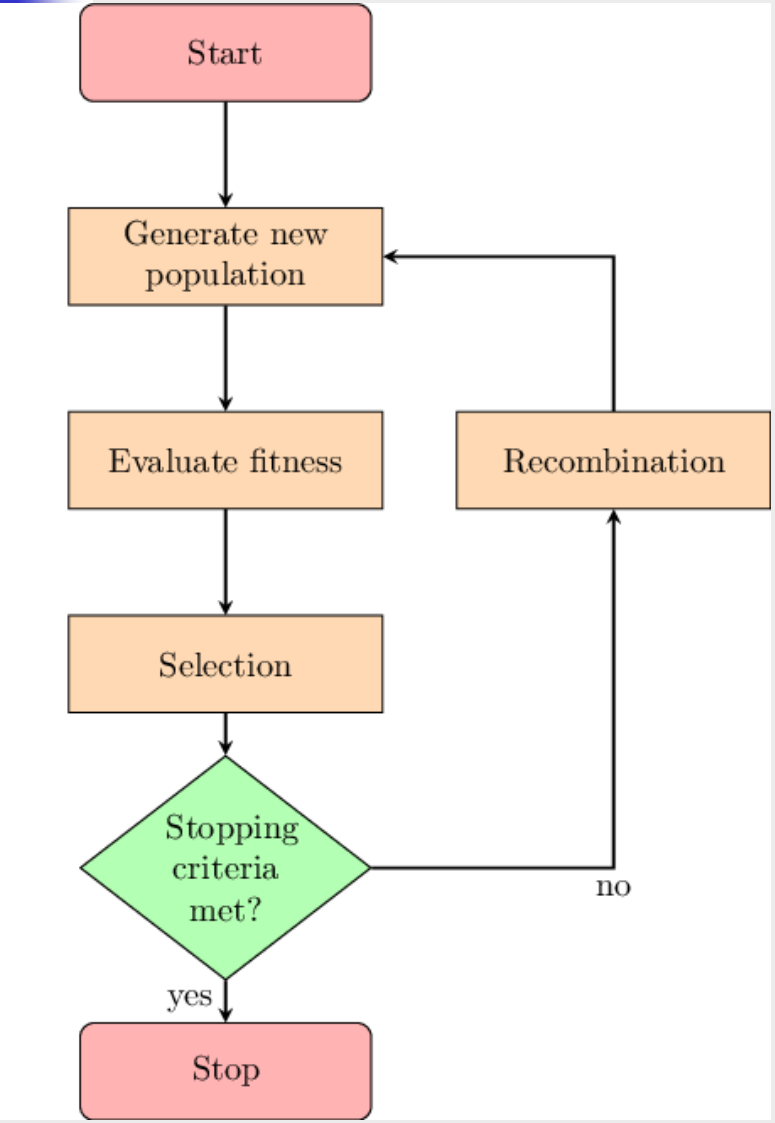
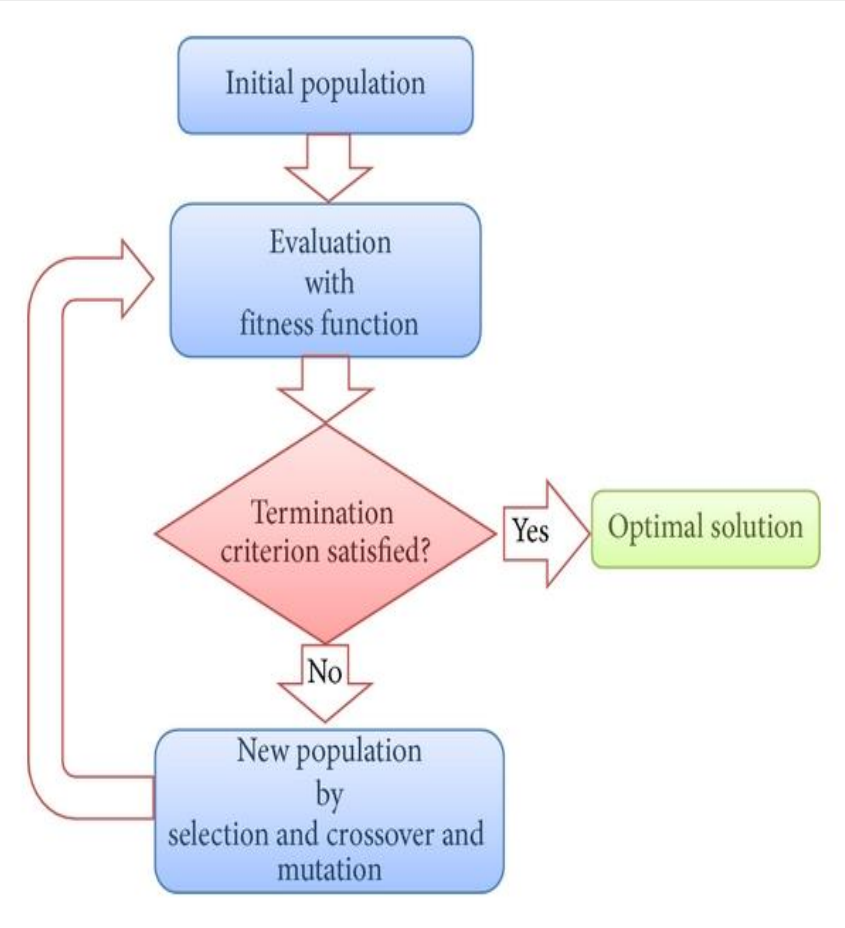
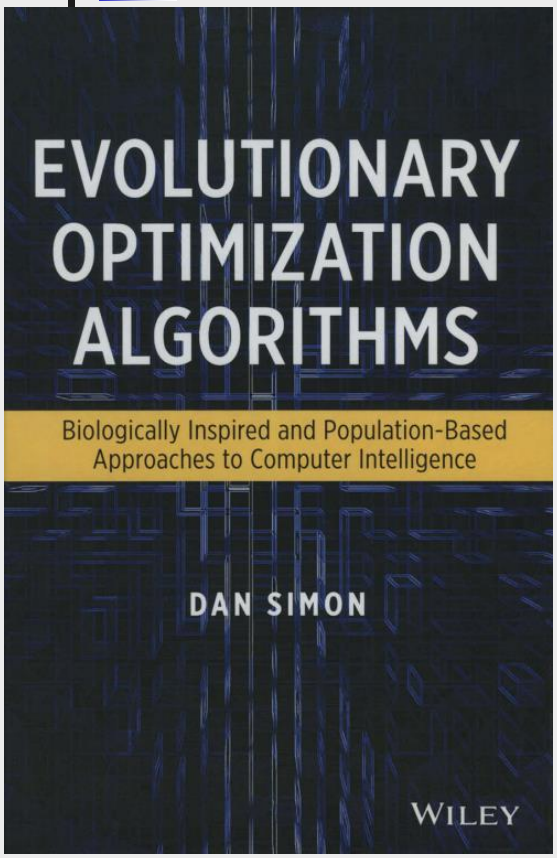
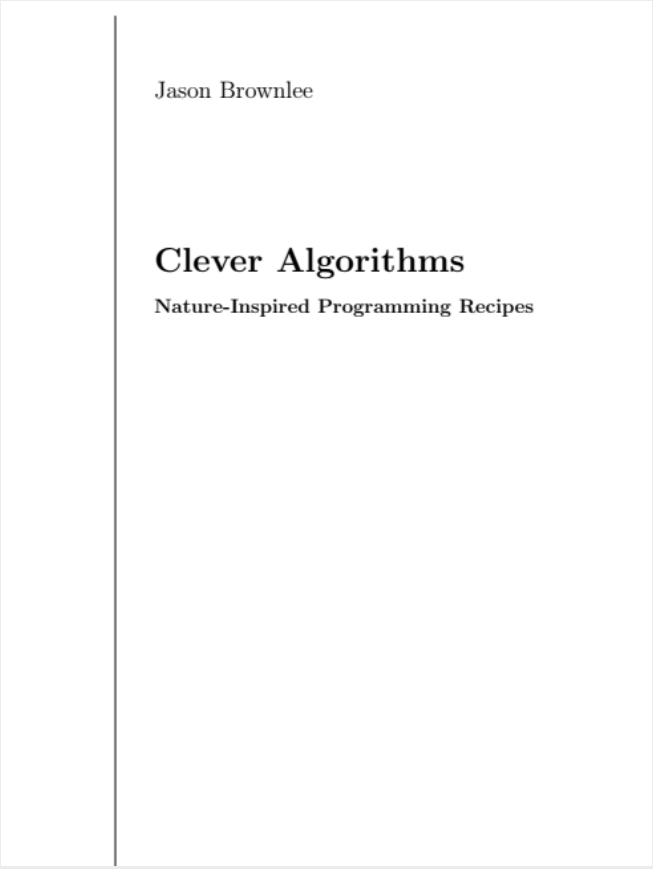
Evolutionary Algorithm Overview

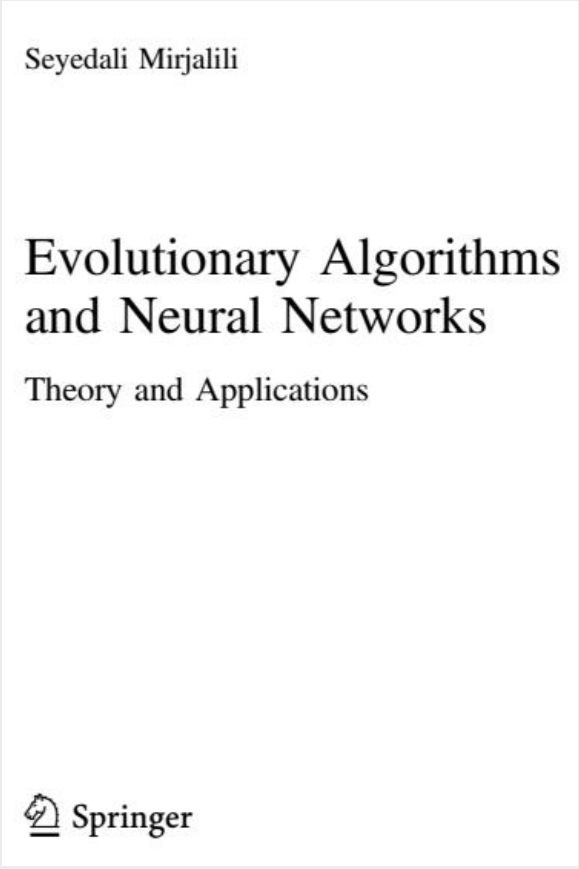




Textbooks


EVOLUTIONARY
OPTIMIZATION
ALGORITHMS
Biologically Inspired and Population-Based
Approaches to Computer Intelligence
DAN SIMON
WILEY


Jason Brownlee
Clever Algorithms
Nature-Inspired Programming Recipes


Seyedali Mirjalili
Evolutionary Algorithms
and Neural Networks
Theory and Applications
Springer

Research Resources

http://www.macs.hw.ac.uk/~ml355/journals.htm

Evolutionary Computing | Neural Computing | Natural Computing | Computational Intelligence | Optimisation and Metaheuristics | Conferences

Evolutionary Computing

Evolutionary Computation MIT Press, 1993-Present, Impact factor 3.600 REF →

IEEE Transactions on Evolutionary Computation IEEE Press, 1997-Present, Impact factor 5.908 REF →

Genetic Programming and Evolvable Machines Springer, 2000-Present, Impact factor 1.143 REF →

Swarm Intelligence Springer, 2007-Present, Impact factor 2.577 REF →

Evolutionary Intelligence Springer, 2008-Present REF →

Journal of Artificial Evolution and Applications Hindawi, 2008-2010 REF →

Memetic Computing Springer, 2009-Present, Impact factor 0.900 REF →

International Journal of Applied Evolutionary Computation IGI Global, 2010-Present

Swarm and Evolutionary Computation Elsevier, 2011-Present, Impact factor 2.963 REF →

International Journal of Swarm Intelligence and Evolutionary Computation OMICS group, 2012-Present

Open Discussion