# **Meta-Heuristic Report**

Course id: AI314

# Autonomous Multiagent Systems

# Instructor : Dr. Mohamed A. Wahby

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| --- | --- |
| Name | ID |
| Ahmed kadry | 20180018 |
| Loai gamal | 20180206 |
| Mohamed sayed | 20180224 |
| Marina moheb | 20180208 |

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 Meta-Heuristic Report

Introduction to Meta-heuristic

At first we want to know what a definition of meta-heuristic in many points:

* a higher-level procedure or heuristic designed to find and generate good solution to an optimization problem.
* We used meta-heuristic especially with incomplete data.
* Metaheuristics sample a subset of solutions which is otherwise too large to be completely enumerated or otherwise explored.
* Metaheuristics may make relatively few assumptions about the optimization problem being solved and so may be usable for a variety of problems.
* The goal is to efficiently explore the search space in order to find near–optimal solutions.

Those is definition of meta-heuristic then we want to know different category’s of it:

1. Evolutionary algorithms
2. Physics-based algorithms
3. Swarm Based algorithms
4. Bio-inspired algorithms
5. Nature-inspired algorithms

We will take to study the first category “Evolutionary algorithms”.

Introduction to Evolutionary algorithms

we want to know what a definition of Evolutionary algorithms in many points:

* Evolutionary algorithm is a subset of evolutionary computation, a generic population-based metaheuristic optimization algorithm.
* uses mechanisms inspired by biological evolution, such as reproduction and selection.
* Finding solutions to the optimization problem play the role of individuals in a population and the function determines the quality of the solutions.
* Evolution of the population then takes place after the repeated application of the above operators.

Those is definition of Evolutionary algorithms then we want to know different types of it:

1. Genetic algorithm.
2. Genetic programming.
3. Evolution strategy.
4. Differential evolution.

So, we need to go-ahead and study the first one ” Genetic algorithm “.

Introduction to Genetic algorithm

we want to know what a definition of Genetic algorithm in many points:

* A genetic algorithm is a variant of stochastic beam search .

So , what is beam search?

* Keeping just one node in memory might seem to be an extreme reaction to the problem of memory limitations.
* The local beam search algorithm keeps track of k states rather than just one.
* It begins with k randomly generated states. At each step, all the successors of all k states are generated.
* If any one is a goal, the algorithm halts. Otherwise, it selects the k best successors from the complete list and repeats.
* So beam search is improvement of simulated-annealing search we add to it an memory and start from k-state randomly.

So, what is simulated-annealing search?

* Its combination between (hill-climb search and random walk mechanism )

So , what is hill-climb search?

* the most basic local search technique.
* At each step the current node is replaced by the best neighbor.
* Best neighbor means the neighbor with the highest VALUE.
* but if a heuristic cost estimate h is used, we would find the neighbor with the lowest h.

Back to our topic, the Genetic algorithm is stochastic beam search that mean its normal beam search but with random k-state , in which successor states are generated by combining two parent states rather than by modifying a single state.

Genetic algorithm how it work

Genetic algorithm complexity

Genetic algorithm advantages/disadvantages

Advantages/Benefits of Genetic Algorithm

Algorithm GAs have several advantages that have made them immensely popular. These include:

* GA use probabilistic transition rules, not deterministic rules.
* GA is good for "noisy" environments.
* GA is robust w.r.t. to local minima/maxima.
* GA can operate on various representation.
* It does not require inferred information (which may not be available for many real world problems)
* It is faster and more efficient compared to traditional methods.
* Good parallel skills.
* Optimize continuous and discrete functions as well as multi-target problems.
* Provides a list of "good" solutions rather than a single solution.
* You will always get an answer to the problem that will improve over time.
* the search space is very large and there are many parameters involved.

**Disadvantages/ Limitations of Genetic Algorithm**

Like any technique, GAs suffer from several limitations, including:

* GAs are not suitable for all problems, especially problems that are simple and for which inferred information is available.
* Since it is stochastic, there is no guarantee of the optimization or the quality of the solution.
* If implemented incorrectly, the GA may not converge to the optimal solution.

Genetic algorithm applications

* Engineering design

has relied heavily on laptop modeling and simulation to form design cycle method quick and economical. Genetic algorithmic program has been wont to optimize and supply a strong solution.

* Traffic and cargo Routing (Travelling salesperson Problem)

this is often a renowned downside and has been with efficiency adopted by several sales-based firms because it is time saving and economical. this is often conjointly achieved mistreatment genetic algorithm.

* Robotics

the usage of genetic algorithm within the field of robotics is kind of big. Actually, genetic algorithm is being used to make learning robots which can behave as a personality's and can do tasks like cookery our meal, do our laundry and so forth

* Economics

GAs are also used to characterize various economic models like the cobweb model, game theory equilibrium resolution, asset pricing, etc.

* DNA Analysis

GAs have been used to determine the structure of DNA using spectrometric data about the sample.

* Robot Trajectory Generation

GAs have been used to plan the path which a robot arm takes by moving from one point to another.

* Parametric Design of Aircraft

GAs have been used to design aircrafts by varying the parameters and evolving better solutions.

# Reference

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