ant colony optimization

# What is ant colony OPTIMISATION?

Ant colony optimization is derived from the biological behavior of ants. Ant drops pheromones on ground to mark the favorable path that will be followed by other ant members of colony. ACO uses this mechanism to solve optimization problems.

Ant colony optimization (ACO) has been formalized into a metaheuristic for combinatorial optimization. *Metaheuristic* is a set of algorithmic concepts that can be used to define heuristic methods applicable to a wide set of different problems. In other words, a metaheuristic is a general-purpose algorithmic framework that can be applied to different optimization problems with relatively few modifications.

# where ANT COLONY OPTIMIzATION IS used?

Routing: Traveling salesman, Vehicle Routing, Sequential ordering.

Assignment: Quadratic Assignment, Course timetabling, Graph colouring.

Scheduling Project Scheduling, Open Shop, Total Weighted tardiness.

Other: Bayesian Networks, Classification rules.

# why ANT COLONY OPTIMIZATION IS used?

***Applications to* NP*-hard problems***

***Applications to telecommunication networks***

ACO algorithms have shown to be a very effective approach for routing problems in telecommunication networks where the properties of the system, such as the cost of using links or the availability of nodes, varies over time.

Ant-based algorithms have given rise to several other routing algorithms, enhancing performance in a variety of wired network scenarios.

***Applications to industrial problems***

# Problems in ant colony optimization

Dynamic optimization problems

Stochastic optimization problems

Multi-objective optimization

Parallel implementation

Continuous optimization

In ACO, a number of artificial ants build solutions to an optimization problem and exchange information on their quality via a communication scheme that is reminiscent of the one adopted by real ants.

# **Algorithm 1** The Ant Colony Optimization Metaheuristic

Set parameters, initialize pheromone trails

**while** termination condition not met **do**

*ConstructAntSolutions*

*ApplyLocalSearch* (optional)

*UpdatePheromones*

**end while**

# Main ACO algorithms

Several ACO algorithms have been proposed in the literature. Here we present the original Ant System, and the two most successful variants: MAX-MIN Ant System and Ant Colony System.

1. Ant System (AS)

Its main characteristic is that, at each iteration, the pheromone values are updated by *all* the m ants that have built a solution in the iteration itself. The pheromone τij , associated with the edge joining cities i and j, is updated as follows:

1. MAX*-*MIN *Ant System (*MM*AS):* This algorithm is an improvement over the original Ant System. Its characterizing elements are that only the best ant updates the pheromone trails and that the value of the pheromone is bound. The pheromone update is implemented as follows:
2. *Ant Colony System (ACS):* The most interesting contribution of ACS [10]–[12] is the introduction of a *local* *pheromone update* in addition to the pheromone update performed at the end of the construction process (called *offline* pheromone update).

The local pheromone update is performed by all the ants after each construction step. Each ant applies it only to the last edge traversed: