

Ant Colony Optimization

By: Aaron Obernuefemann

October 22nd, 2012

Data Mining Methods MATH 3220

Overview

- Definition of Ant Colony Optimization (ACO)
- Terminology
- Metaheuristics
- The Algorithm
- ACO Example
- Summary
- References

Definition

- Ant colony optimization (ACO) is a population-based metaheuristic that can be used to find approximate solutions to difficult optimization problems.
- (ACO) studies artificial systems that take inspiration from the behavior of real ant colonies

Terminology

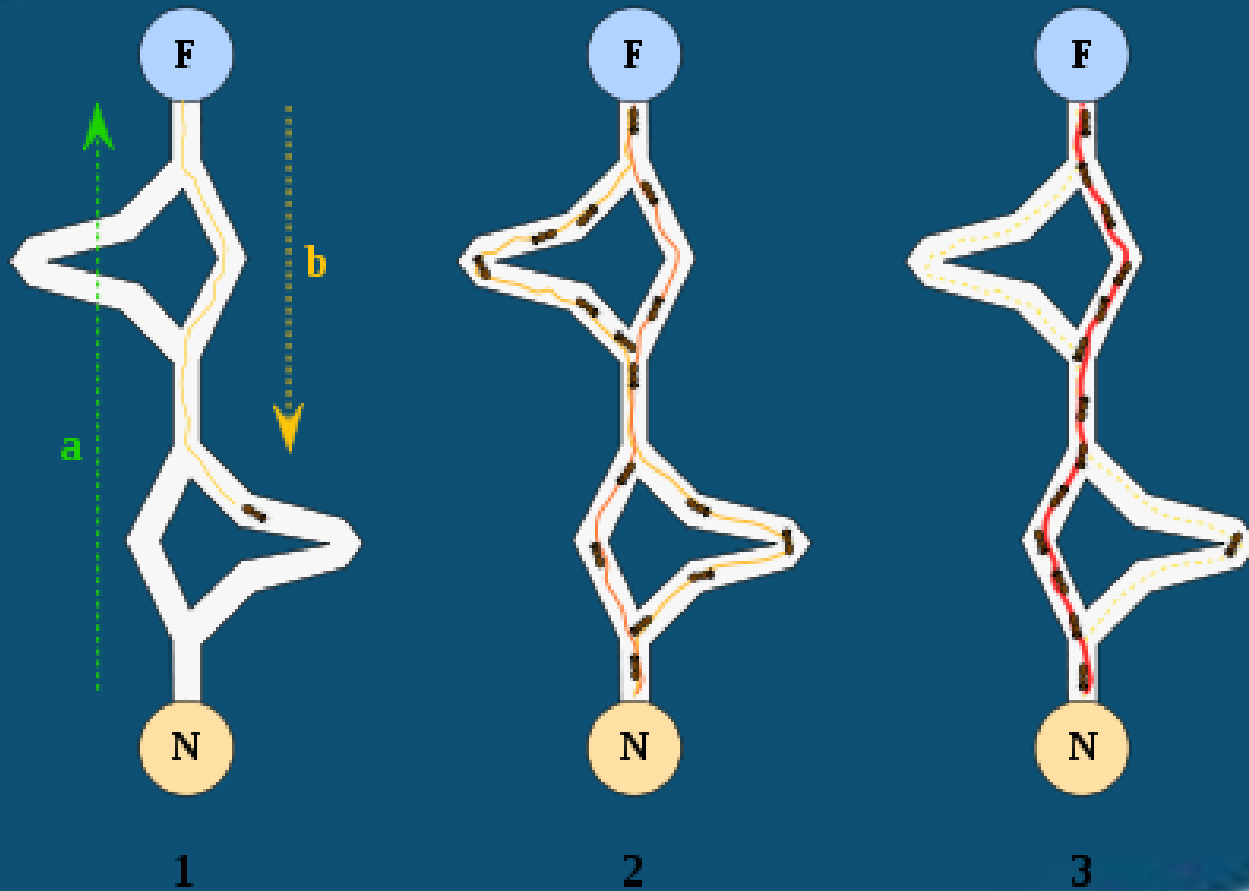
- Pheromones- markers
- Combinatorial Optimization (CO)- a topic that consists of finding an optimal object from a finite set of objects
- Computational Complexity- A mathematical characterization of the difficulty of a mathematical problem which describes the resources required by a computing machine to solve the problem
- Heuristic- pertaining to a trial-and-error method of problem solving used when an algorithmic approach is impractical

Metaheuristics

- Guides other heuristics to search for solutions in domains
- Generally applied to problems classified as NP-Hard or NP-Complete by the theory of computational complexity
- Also applied to other combinatorial optimization problems

The Algorithm

- proposed by Marco Dorigo in 1992
- a member in swarm intelligence methods and it constitutes some metaheuristic optimizations
- a probabilistic technique for solving computational problems which can be reduced to finding good paths

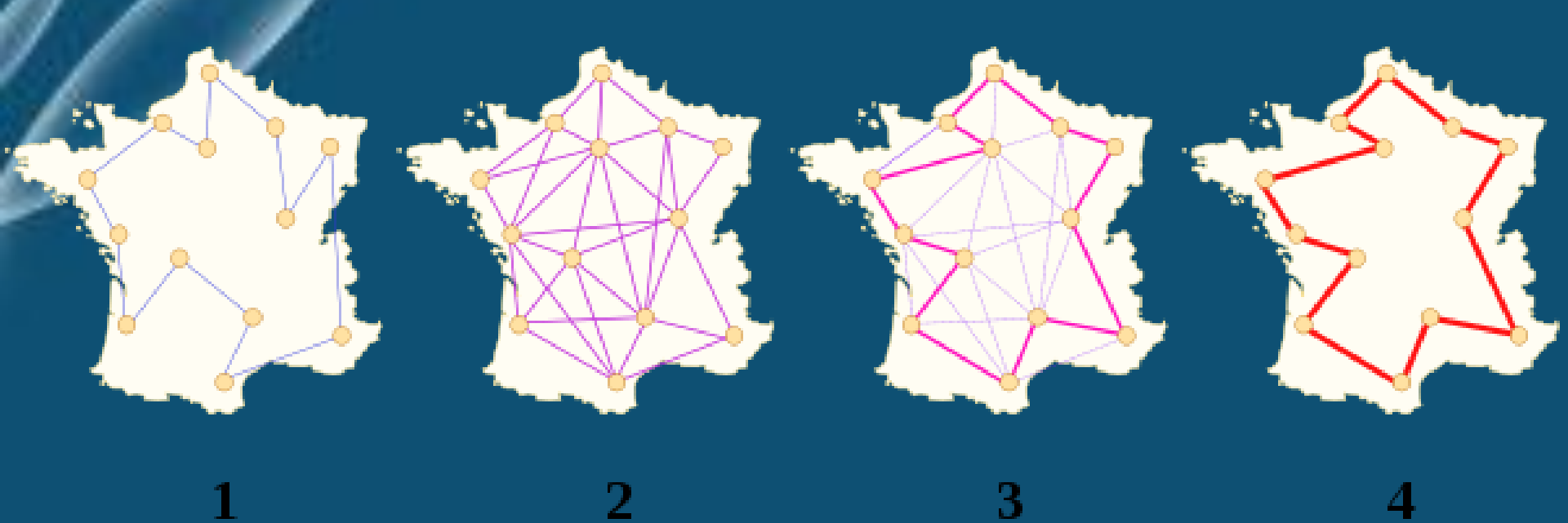


Picture Source: Wikipedia

F = Food ; N = Nest

ACO Example: Traveling Sales Problem

- Marco Dorigo described in 1997 a method of heuristically generating "good solutions" to the TSP using a simulation of an ant colony system called ACS(Ant Colony System)
- It models behavior observed in real ants to find short paths between food sources and their nest
- Each ant probabilistically chooses the next city to visit based on a heuristic combining the distance to the city and the amount of virtual pheromone deposited on the edge to the city.
- The amount of pheromone deposited is inversely proportional to the tour length: the shorter the tour, the more it deposits.



- sends out a large number of virtual ant agents to explore many possible routes on the map
- the ants explore, depositing pheromone on each edge that they cross, until they have all completed a tour
- the ant which completed the shortest tour deposits virtual pheromone along its complete tour route (*global trail updating*)

Summary

- Defined ACO
- Metaheuristics
- The Algorithm
- Traveling Sales Problem

References

- "Ant Colony Optimization." - *Scholarpedia*. N.p., n.d. Web. 11 Oct. 2012.
<http://www.scholarpedia.org/article/Ant_colony_optimization>.
- "Metaheuristic." *Dictionary.com*. Dictionary.com, n.d. Web. 12 Oct. 2012. <<http://dictionary.reference.com/browse/metaheuristic>>.
- "Tabu Search." *Reference.com*. N.p., n.d. Web. 12 Oct. 2012.
<http://www.reference.com/browse/Tabu_search>.
- "Ant Colony Optimization Algorithms." *Wikipedia*. Wikimedia Foundation, 3 Apr. 2010. Web. 15 Oct. 2012.
<http://en.wikipedia.org/wiki/Ant_colony_optimization_algorithms>.
- "Travelling Salesman Problem." *Wikipedia*. Wikimedia Foundation, 10 Jan. 2011. Web. 18 Oct. 2012.
<http://en.wikipedia.org/wiki/Travelling_salesman_problem>.
- <http://dictionary.reference.com/browse/heuristic?s=t>

Questions?