Runtime Analysis of Ant Colony Optimization Algorithms

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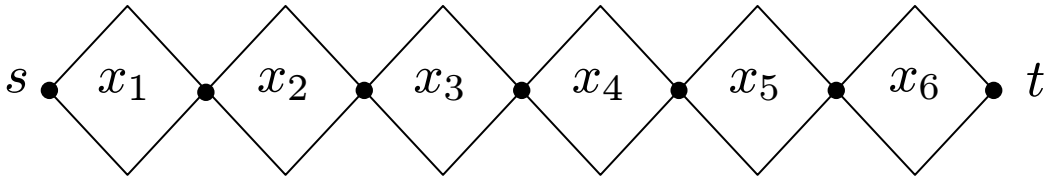
Introduction:

- Ant Colony Optimization (ACO) is a kind of randomized search heuristic.
- Developed and sucessfully applied to combinatorial optimization problems.
- Runtime analysis of ACO algorithms is a challenging task [3].
- No results until 2006.
- Better understanding and theoretical foundation for in practice successful algorithms.

Principle:

- Solutions are constructed by random walks on a construction graph.
- A walk is influenced by pheromone values and/or heuristic information on the edges.
- Pheromone values are updated depending on constructed solutions.
- "Good" solutions are rewarded depending on an update parameter.



Construction graph for pseudo-Boolean functions $f\colon \{0,1\}^n \to R$

Large Updates (Pseudo-Boolean Functions):

- Behavior as a well-known evolutionary algorithm called (1+1) EA.
- Transfer many results to a simple ACO algorithm [6].

More detailed investigations on Updates (Pseudo-Boolean Functions):

- Simple functions such as OneMax, LeadingOnes, BinVal.
- Phase transition for a simple ACO algorithm with respect to the update parameter if new non-inferior solutions are rewarded [1,2,6].
- Runtime depends inverse-proportional to the update parameter if always the best solution obtained so far is rewarded [4].

Construction Graphs (Minimum Spanning Trees) [5]:

- Input graph causes in the worst case exponential runtimes.
- More component-based construction graph is better suited and makes ACO algorithms (in a certain parameter setting) behave like Kruskal's algorithm.

References:

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