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January 6, 2010

Discrete Mathematics for Bioinformatics (P1)

WS 2009/10

Exercises 9

1. *Metaheuristics*

Given the complete undirected graph $G = (V, E)$ for a set of V of vertices, and a function $w : E \mapsto \mathbb{R}^+$ that assigns a positive weight to each edge. The *Traveling Salesman Problem* (TSP) is to find a cyclic path in G that contains each vertex in V exactly once and has minimal total weight.

- (a) Describe a brute force algorithm for solving the TSP.
- (b) Describe several heuristics to approximate the TSP. Use at least the following techniques:
 - Iterated local search.
 - Simulated annealing.
 - Ant colony optimization.
 - Evolutionary computing.

You may also evolve your own ideas.

- (c) How can the TSP be formulated as ILP?

2. Bellman Ford Algorithm

- (a) Use the Bellman-Ford algorithm to determine the shortest path from source A to any other node in the graph.
- (b) Let $D = (V, A), n = |V|$ be a directed graph. Prove that D contains a circuit of negative length if and only if $f_n(v) \neq f_{n-1}(v)$, for some $v \in V$, where $f_k(v) = \min\{l(P) \mid P \text{ is an } s - v \text{ walk traversing at most } k \text{ arcs}\}$

