Exercises, Algorithm Design II, Fall 2012

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The case studies consider data sets that can be found via the course home page. The class will split into smaller groups that work on one of the cases, and later each group should present their algorithm design. Implementing the solution after the exercises is encouraged, and could yield components useful for the final project. It is part of the case studies to clarify what exactly should be computed, and what assumptions on data can be made.

Algorithm Design Case Study: Low-degree triangles

We consider the Wikipedia vote network: `http://snap.stanford.edu/data/wiki-Vote.html`. This directed graph contains 608389 triangles, i.e., patterns of the form "A voted for B, B voted for C, C voted for A". We wish to compute a count of triangles consisting only of "low degree" nodes that have out-degree at most 10.

Your task is to design a scalable algorithm for this problem. It is possible to significantly improve on the $O(|V|^3)$ time achieved by iterating over all possible triangles. Use suitable data structures.

Extra credit: Does your algorithm extend to finding simple cycles of any length k?

Algorithm Design Case Study: TSP

We consider Traveling Salesperson Problems: `http://www.tsp.gatech.edu/world/countries.html`.

The basic task is to find the shortest route that passes each of n points exactly once, assuming Euclidian distance between points. The start and end point can be chosen arbitrarily. It can be shown that this problem is NP-hard.

A brute-force algorithm is to consider all $n!$ possibilities. (How large n are feasible using this method?) Your tasks are:

1. Design a dynamic programming algorithm that finds an shortest route in time $O(n^3 2^n)$.
   Hint: Consider optimal routes for subsets of towns.

2. Design an algorithm that finds a shortest route for visiting *any* k points.

In 2004 an optimal TSP tour of 24,978 towns and cities in Sweden was found using over 80 machine-years of computer power. Can you find an optimal tour of the 29 towns of Western Sahara?