Efficient Route-Planning in Huge Graphs

With Limited Resources

Ondrej Moriš

Faculty of Informatics
Masaryk University
xmoris@fi.muni.cz

Abstract. In this work we are concerned with a route-planning problem in huge graphs such as real-world road maps. In this problem we are given two end positions and we want to find the best route between them with respect to chosen criteria. We propose a new hierarchical two-level approach based on a clarification of a well-known cell search method. We introduce a notion of edge scope that is able to ensure a natural human thinking about the route-planning via rigorous mathematical assumptions and plays an important role in a preprocessing step as well as in subsequent queries. In particular, it seems that our approach could be very applicable for mobile devices because of its memory efficiency and sufficient speed-up.

The route-planning problem can be viewed as a special instance of a well-known *single pair shortest path problem*. It is already known that this problem can be solved in linear time using classical Dijkstra's algorithm which is really good in general, but rather ineffective and slow for huge graphs representing real-world road maps. On the other hand if some really strong heuristics are employed to speed-up the search very loose results are usually obtained. We believe that a true solution should carefully use some kind of abstraction of a road map to ensure efficiency as well as accuracy and currently almost every fruitful route-planning approach demonstrates the truth of this belief.

In this thesis we have developed a hierarchical two-level approach to the static route-planning that is focused, in particular, on the following five goals:

- minimization of computing memory needed to answer query
- reduction of the size of precomputed auxiliary data
- provably optimal paths w.r.t. specific optimality criteria
- fast queries and fast and scalable preprocessing
- ability to handle simple road map changes

In order to accomplish these goals we have introduced a new road parameter – a *scope* of an edge. And we have incorporated it into so-called cell search. We have also dropped the exact shortest paths requirement but the difference between the resulting path and the optimal one is in general negligible for the practical route-planning.