Provenance-Based Routing in Road and Transport Networks

École normale supérieure & Université Paris-Sud

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Context

Routing (i.e., finding the shortest path) in road and transport networks is a rich research area, with current algorithms being able to answer routing queries in sub-millisecond times [BDG+15]. The current state-of-the-art uses algorithms that compute hierachies of routing in networks, using *contraction hierarchies* of shortcuts in the network [GSSD08]. Such an approach works very well with very sparse networks, and more specifically with networks of *low treewidth* [PdWvdK12], or *low highway dimension* [AFGW10].

On the other hand, it is known that graph of low treewidth allow tractability of an important classes of problems [Gro07], such as probability estimations [ABS15]. The main avenue of enabling is the computation of *provenance* (or *lineage*) circuits. Provenance circuits are a succinct way to represent query answers on a relational instance, by encoding them as elements of a semiring [Moh02, GKT07].

The objective of this internship is to study richer query semantics in transport and road networks, in particular those in which provenance is used. These can be: (i.) computing routing information when probabilistic information is present (e.g., road closures, uncertain travel time) and where current approaches do not work directly; (ii.) computing top-k relevant paths; or (iii.) computing a diverse set of routing paths.

Tasks

The mission of the student is to study the ways in which provenance-based methods can be successfully applied to routing in road and transport networks. In particular, the student will study previous approaches in routing for road networks [GSSD08, PdWvdK12], on semiring-based provenance computing [Moh02], and will be tasked with identifying the avenues for adapting these algorithms for road and transport networks.

In summary, the completion of the following tasks is expected:

- Identifying and processing possible relevant data sets (OpenStreetMap, STIF, etc.).
- Adapting and analyzing known algorithms for routing in road networks for computing provenance.
- Implementing those algorithms, possibly requiring adapting already existing C++ code.
- Writing a report on the research and the delivered source code.

The internship will take place within the computer science department at École normale supérieure (45 rue d'Ulm, Paris 5), in the Valda team led by Prof. Pierre Senellart, in close collaboration with LRI at Univ. Paris-Sud (Silviu Maniu) and Inria Paris (Laurent Viennot).

References

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