PhD Lecture

In partial fulfillment of the terms for obtaining the PhD degree, Robert Waury will give a lecture on the following subject:

In-Memory Trajectory Indexing for On-The-Fly Travel-Time Estimation

on Monday 28th of October 2019, 13:00, in room 0.2.13 at Selma Lagerlöfs Vej 300

Abstract:

This thesis presents a new method that is able to efficiently select subsets of sub-trajectories from a set of network-constrained vehicle trajectories. The method can be used to improve the quality of histogram-based travel-time estimates for paths in the underlying road network by identifying the trajectories that are most relevant for a given road network path and time. The thesis shows this with a series of detailed qualitative studies based on real-life trajectory data sets capturing several years of vehicular travel in Northern Denmark. We observe that the quality of travel-time estimates depends heavily on the type of road and whether the road is located in a rural or an urban area. After demonstrating the quality improvements provided by our method over previous approaches, we design a network-constrained trajectory index to efficiently apply our proposed collection method to compute travel-time histograms. The proposed in-memory index utilizes methods from string processing as a spatial index to identify trajectories in the indexed data that traverse a given path. The majority of its memory footprint is in the temporal index that comprises a collection of B+-trees or CSS-trees. To further increases performance, we integrate the new index with a very accurate cardinality estimator that allows us to minimize the accesses to the considerably larger temporal index. To augment our collection method, we propose a greedy algorithm that allows our index to provide a best-effort travel-time estimate even if few trajectories matching a path are available. This is achieved by allowing the index to rewrite a path-based travel-time query as a series of sub-queries that each cover only a sub-path of the original query path by partitioning the path in multiple iterations until a viable sub-query is found. We perform an extensive performance study and qualitative analysis of our index structure and partitioning strategies. We show that our method for travel-time estimation exhibits performance suitable for real-time applications when used in conjunction with our in-memory index. To show the scalability of the index, we integrate it into a multi-threaded trajectory store that allows to concurrently update and query the indexed trajectory set. To gain the full advantages of a multi-threaded application, we test it on a modern multi-core system. Modern multi-core systems increasingly adopt a non-uniform memory access (NUMA) architecture, which necessitates different software design approaches compared to those for systems providing uniform memory access. We propose several optimizations to make the trajectory store NUMA-aware and provide an extensive experimental study of the system that shows considerable performance improvements over the non-optimized version. Further, we propose a path-based API for trajectory analysis that allows the aforementioned systems to be integrated easily into trajectory analysis applications.

Members of the assessment committee are Professor Karine Bennis Zeitouni, University of Versailles Saint-Quentin, Associate Professor Alberto Belussi, Università degli Studi di Verona, and Professor (MSO) Bent Thomsen, Aalborg University. Professor Christian S. Jensen and Professor (MSO) Kristian Torp are Robert Waury's supervisors. Moderator Associate Professor Christian Thomsen.

All interested parties are welcome. After the defense the department will be hosting a small reception in cluster 3.