Candidate Sets for Alternative Routes in Road Networks [1]

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Modelling Alternatives
- concatenation of two shortest paths at via node
- must adhere to quality criteria

Quality Criteria
- uniformly bounded stretch
  - each subpath should not be too much longer than a shortest path \( k < 25\% \)
- maximum overlap
  - paths should not have too many subpaths in common \( t < 80\% \)
- local optimality
  - all local decisions along a path should make sense \( s < 25\% \)

Baseline Algorithm [2]
- grow search spaces from \( s \) and \( t \)
- plateaus yield candidates for via nodes

Algorithm is named according to underlying shortest path technique, e.g. X-BDV, X-CHV, X-CHASEV, …

Conjecture (limited number of alternative paths)
If the number of shortest paths between two regions of a road network is small, so is the number of plateaus. Likewise, the number of admissible alternatives is small and can be covered by few via nodes.

Idea (Single-Level)
- partition graph into regions
- compute via node candidate set for each pair of regions
- examine sets during query

Query
- determine via node candidate set for the considered region pair
- check via node candidates in set
- stop when quality criteria are fulfilled
If regions are neighboring or the same, baseline algorithm is used.

Preprocessing
Our algorithm is used for bootstrapping:
- compute alternatives for all pairs of boundary nodes for all region pairs
- if no alternative is found, run baseline algorithm to compute new via node
- add node to respective via node candidate set

Engineering: parallelization, sampling, storing search spaces, …

Extension (Multi-Level)
Partitioning can be done in multiple levels. If source and target regions are neighboring or the same, the algorithm recurses to a finer level.

Experimental Evaluation
Algorithms are implemented in C++ and compiled with g++ 4.5 using full optimizations. Queries use a Core i7-920 at 2.66 GHz (12 GiB). Preprocessing uses 4 Opteron 6168 at 1.90 GHz (256 GiB). Experiments are done on the road network of Western Europe, as provided by PTV AG for the 9th DIMACS Implementation Challenge.

Online Algorithm
Can be added on top of a legacy system. Via node candidate sets start empty. If our algorithm does not yield an alternative, the baseline algorithm is applied as fallback and the found via node added to the appropriate set. Failbacks are stopped after sets become saturated.

Alternative Graphs
- summarize multiple alternatives
- provide a sparse set of options
- computable from via node candidate sets

Bibliography