Karlsruher Institut für Technologie

Algorithmic Cartography – Labeling

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Overview

Algorithmic Cartography: With increasing popularity of interactive maps, e.g., as digital globes or on mobile devices, algorithms for creating maps become more and more important.

Labeling: Non-overlapping labels for various map features is an important cartographic problem.

Static Maps:
- Map is completely visible.
- Map does not change over time.

→ Typical Problem: Find a maximum independent set of labels.

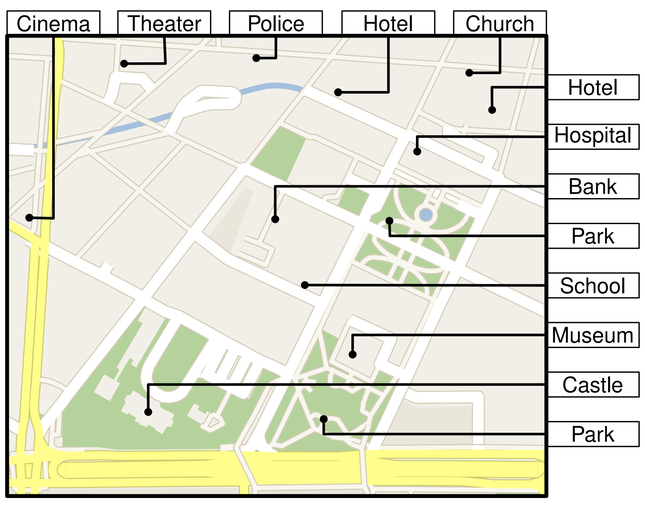
Dynamic Maps:
- Map is only partly visible.
- Map changes over time.

→ Typical Problem: Find consistent & continuous adaption of the labeling.

Methodology: Computational geometry, graph drawing, combinatorical optimization, algorithm engineering.
Goal: Algorithms with guarantees for quality and performance.

Research Interests – Two Examples

Boundary Labeling

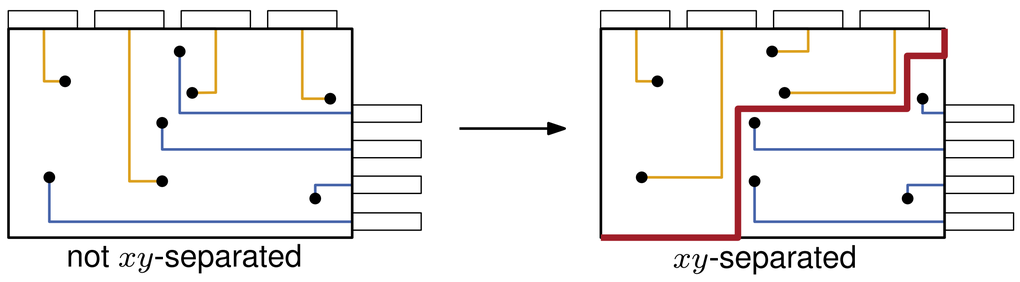


Two-Sided Boundary Labeling with Adjacent Sides:
- Rectangular section R of map.
- Labels in form of uniform rectangles along two adjacent sides of R.
- Sites on R in form of points.

Goal: Find *optimal* matching between labels and sites connecting them with *leaders*.

Requirements:
- Minimize badness function, e.g., total length of leaders.
- Leaders may not intersect each other, i.e., find *crossing-free matching*.

Structure of Solution:

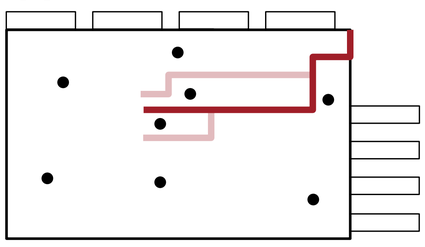


not xy-separated

xy-separated

Theorem: If there is a crossing-free matching, then there is also an xy-separated crossing-free matching.

Approach:



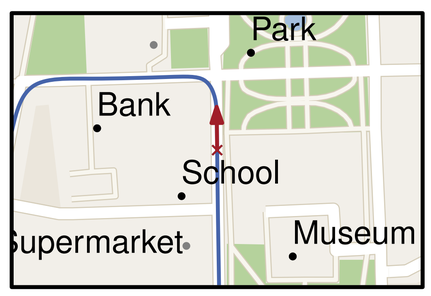
Dynamic program finds xy-separating curve in $O(n^2)$ time.

→ Crossing-free matching minimizing the total leader length can be computed in $O(n^2)$ time.

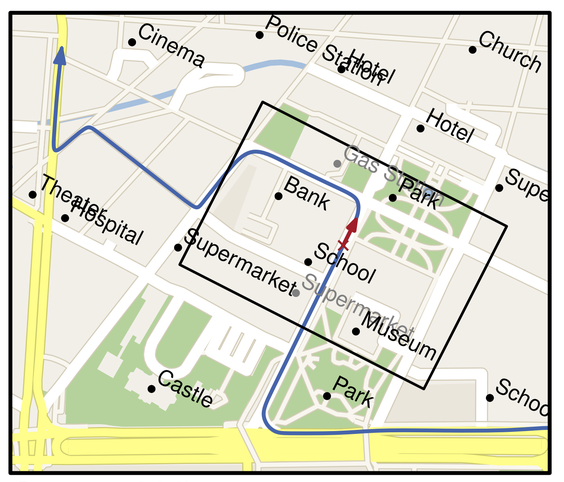
Joint Work with: Philipp Kindermann, Ignaz Rutter, Marcus Schaefer, André Schulz, and Alexander Wolff.

Publication: Two-Sided Boundary Labeling with Adjacent Sides. In: *Algorithms and Data Structures, 13th International Symposium (WADS'13), Lecture Notes in Computer Science. Springer, 2013.*

Trajectory-Based Map Labeling



User's View, e.g., GPS navigation system.



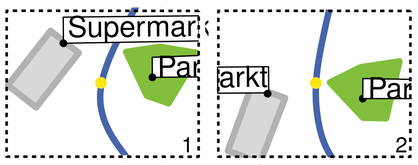
General View

Goal: Compute an *optimal consistent* labeling of a map along a given smooth trajectory.

Requirements:
- Maximize over all views the number of displayed labels.
- Displayed labels may not overlap.
- Satisfy consistency criteria.

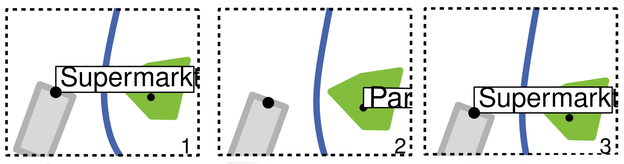
Consistency Criteria:

No 'jumping' labels.



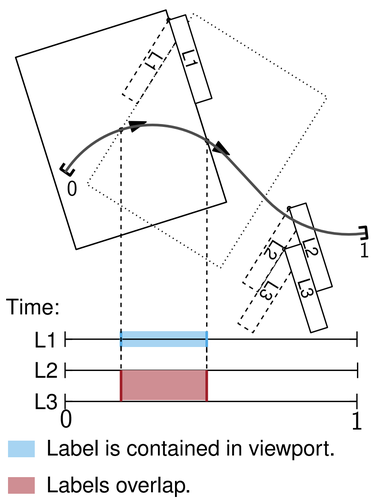
The label *Supermarket* jumps in the second frame.

No 'flickering' labels.



The labels *Supermarket* and *Park* are displayed alternately.

Approach:



Abstraction of Problem
- Represent intersection between viewport and label by time intervals.
- Represent intersection between two labels by time intervals.

→ Developed algorithms require only time intervals.

General Case: NP-complete, approximation algorithms.

Display $\leq$ k labels at the same time: (Reduction of displayed information.) Polynomial solvable with dyn. program.

Joint Work with: Andreas Gemsa and Martin Nöllenburg.