Health-Optimal Routing in Urban Areas

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High-Resolution Pollution Maps

Data collection using ten mobile sensor nodes on top of public transport vehicles

• Sensors: O_3, NO_2, CO, ultrafine particles
• Land-use regression model

Node with low-cost sensors   *Sensor box on top of a tram*

Air pollution maps of Zurich with spatial resolution 100m x +100m

Ultrafine Particles (UFPs)

Nanoscale particles with a diameter of less than 100 nanometers

• Believed to have more severe health implications than PM_{10} or $PM_{2.5}$
• Lack of spatially resolved exposure data

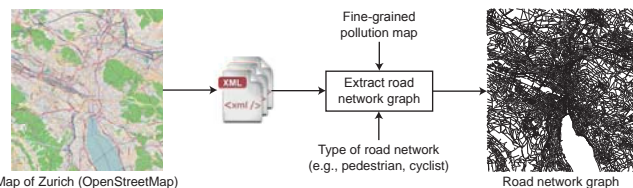MiniDiSC: First compact UFP measurement device suitable for mobile measurements

MiniDiSC device

Health-Optimal Routing for City Dwellers

Offer route planning service to calculate routes that are health-optimal, i.e., minimize the total number of inhaled particles

Road Network Graph

Road network of Zurich based on OpenStreetMap data

Map of Zurich (OpenStreetMap)

Fine-grained pollution map → Extract road network graph → Road network graph

Type of road network (e.g., pedestrian, cyclist)

Road network is an undirected graph $G = (V, E, W_d, W_p)$

• Each node $v_i \in V$ represents a crossroad or dead-end street

• An edge $e_j \in E$ connects two nodes if they are directly connected by a road segment

• Each edge is associated with two weights:
  - $w_{d,j} \in W_d$ denotes the length of the road segment
  - $w_{p,j} \in W_p$ denotes the expected pollution exposure

• Size of Zurich's road network graph:
  - $|V| = 27,000$; $|E| = 74,000$

Comparing Shortest and Health-Optimal Paths

Analyzing length and pollution exposure differences of the two paths


Routing from Albisrieden to Wollishofen

Routing from Wiedikon to Witikon

Shortest path / Health–optimal path

Differences are most significant during fall months (based on 1000 random source-destination pairs):
• Average exposure reduction of 7.1%
• Average path length increase of 6.4% (548 m)

iOS & Android Application

• Effective implementation of least-cost pathfinding algorithm on mobile devices
• Available for free on iTunes / Google Play Store as *hRouting - The Health-Optimal Route Planner*
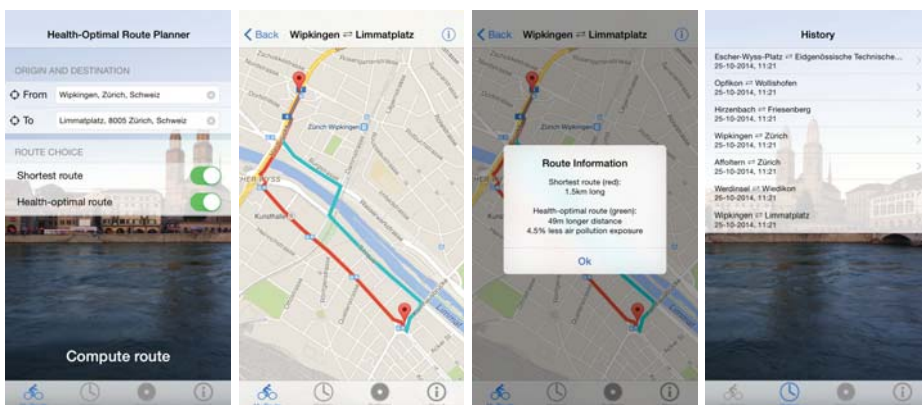
Compared 5000 random source-destination pairs on various iOS devices

Average computation times:
• 14ms on iPad mini 2
• 28ms on iPhone 5
• 80ms on iPhone 4 & 4s