We developed an intelligent route planning system that helps cyclists discover routes that best suit their needs. Proposed solution takes into account the difficulty of manoeuvres at junctions and employs multi-criteria route search with several speed-up heuristics.

### Extended Cycleway Graph Model

- OpenStreetMap → graph model for planning
- Extension of graph model – certain maneuvers at junction are more dangerous than others (left turn ≠ right turn)

### Motivation

- Cycling is crucial for achieving more sustainable urban mobility
- Navigating on a bike is challenging – fragmented cycling infrastructure, hills
- Cyclists have multiple route choice criteria: trip distance, turn frequency, slope, junction control, manoeuvres at junctions, surface quality, traffic volumes, ...
- Multi-Criteria Bicycle Route Planner is needed, but none exists

### Multi-Criteria Bicycle Route Planning

- Three criteria (distance, elevation gain, and bike friendliness)
- Solves issues of single criteria approach with weighted sum of cost vector
- Pareto set of routes
- Optimal MCD algorithm too slow – we proposed Pruning heuristics

### Evaluation of the Best Pruning Heuristic

- Speed up – 4000x faster then optimal MCD algorithm
- Solve problems on graphs with 141,117 nodes and 323,114 edges in 2.3 seconds on average – whole city of Prague
- Approximately 10.6% difference in each criterion from optimum

### Practical Deployment

- World unique bicycle route planner with real users
- RESTful API – daily serves 200 requests on average
- Web frontend www.cykloplanovac.cz
- Android application – 1900 active users
- Tracked data helps to improve routing and to analyse problems in cycling infrastructure

### Publications