



# Large-scale Vehicle Routing Scenarios based on Pollutant Emission

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# Traffic Assignment

## Per-participant Route Choice

Given a large-scale simulation scenario we need to compute the used routes of each participants

- Fastest route, but
  - Not through the empty network, but
  - Through the network under load
- Traffic Assignment (we use Gawron's<sup>(\*)</sup> algorithm)
- Individual: each participant has an own route
  - Uses travel times from simulation runs → regards traffic lights, delays due to turns etc.

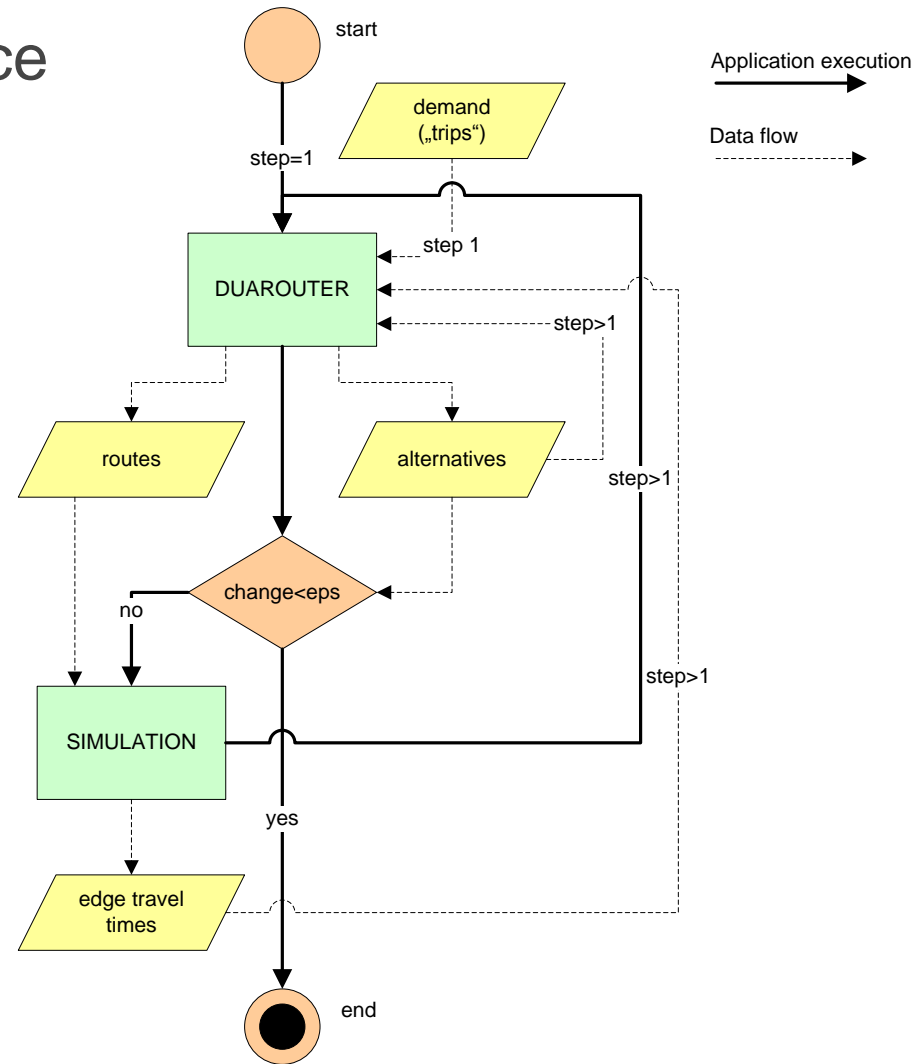
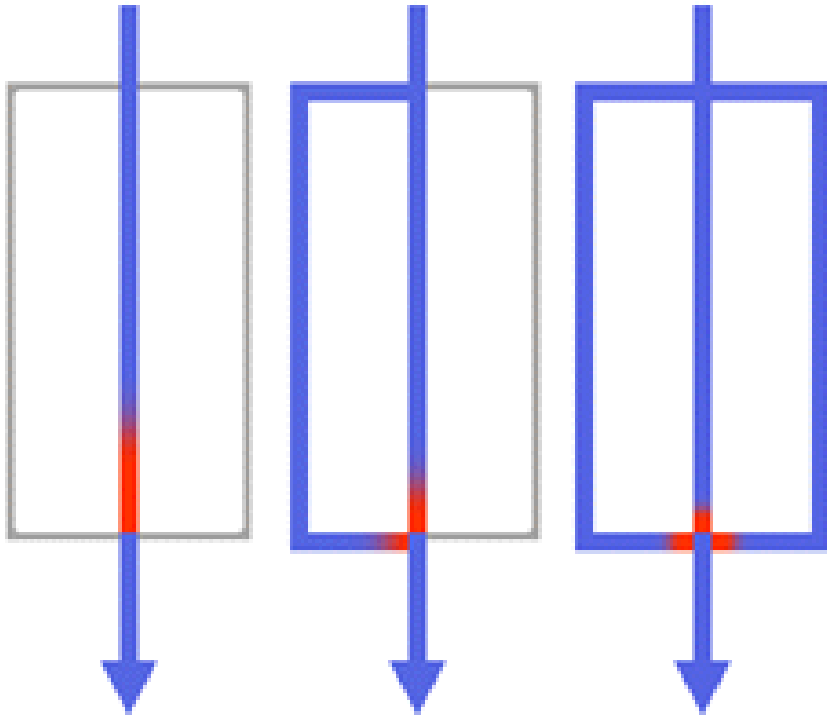
At the end, we obtain a set of routes for all participants, regarding the situation on the roads

(\*) Christian Gawron. 1998. "Simulation-Based Traffic Assignment". Inaugural Dissertation.



# Traffic Assignment

## Per-participant Route Choice





# Eco-Routes

## Problem Description

Usually travel time is used – the fastest way through the network

- Not 100% real-world behavior, but the best what we have so far

But: what happens if other measures are used?

- Sometimes available in web portals: fuel consumption
- We are interested in pollutant emissions, too

Are global emissions minimized if everyone tries to reduce her/his emissions?

What happens to the route distribution – which roads are taken?

# Emission Model

## HBEFA reformulation

Wanted: a model for CO, CO<sub>2</sub>, HC, PM<sub>x</sub>, NO<sub>x</sub> emission and fuel consumption

- 15 models were evaluated
- HBEFA was chosen as it includes values for all wanted pollutants and models the (almost?) complete population

HBEFA is a database with emission factors; we reformulated it into a continuous model

- Fit values to a formula for needed force

$$EF_p(v, \alpha) = c_0 + c_{va_1} v a + c_{va_2} v a^2 + c_1 v + c_2 v^2 + c_3 v^3$$

- Clustered the obtained functions into abstract vehicle classes

Additionally: extended the dynamic traffic assignment for using other values than travel time → each participant tries to reduce her/his emissions

# Used Scenario

## City of Bologna

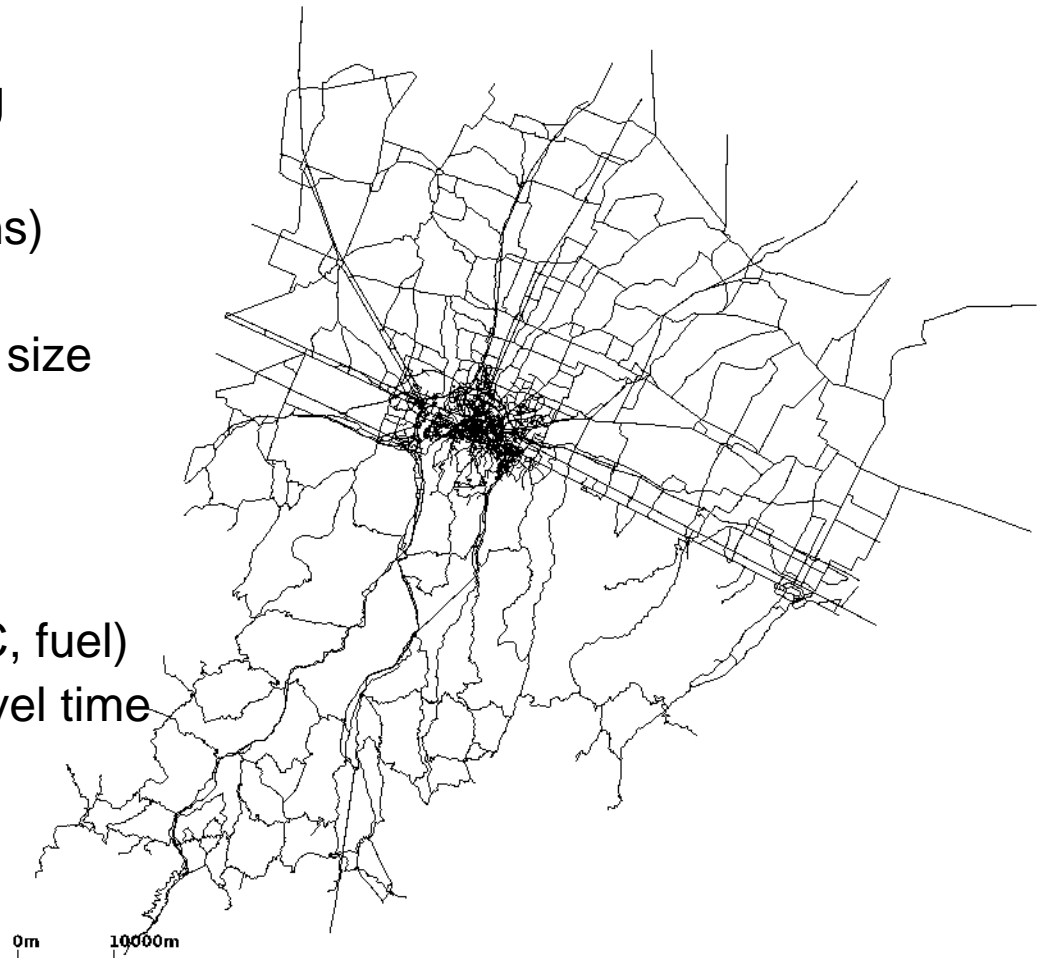
### Bologna and Surrounding

- 104141 vehicles
- 5958 nodes (intersections)
- 13259 edges (roads)
- Approx. 50km x 50km in size

### 6+1 Assignments

- One per measure (6)  
(CO, CO<sub>2</sub>, NO<sub>x</sub>, PM<sub>x</sub>, HC, fuel)
- One conventional by travel time
- 30 iterations each

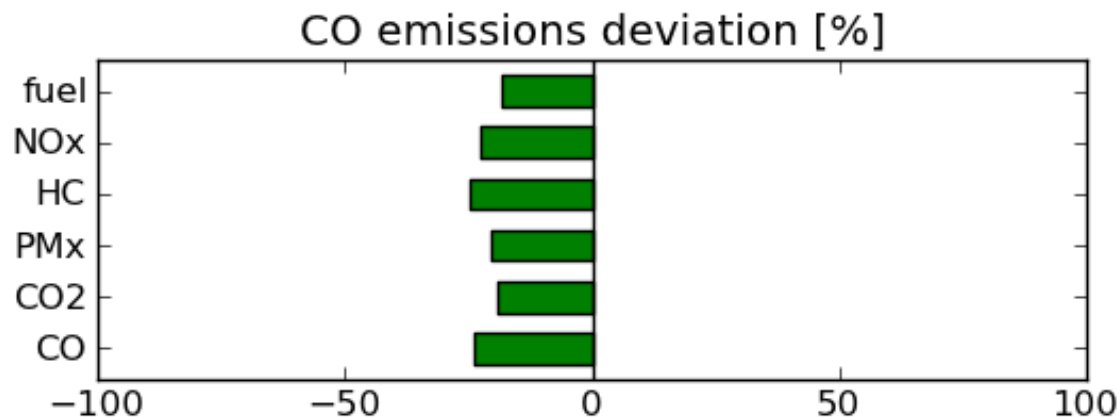
Using SUMO...



# Results

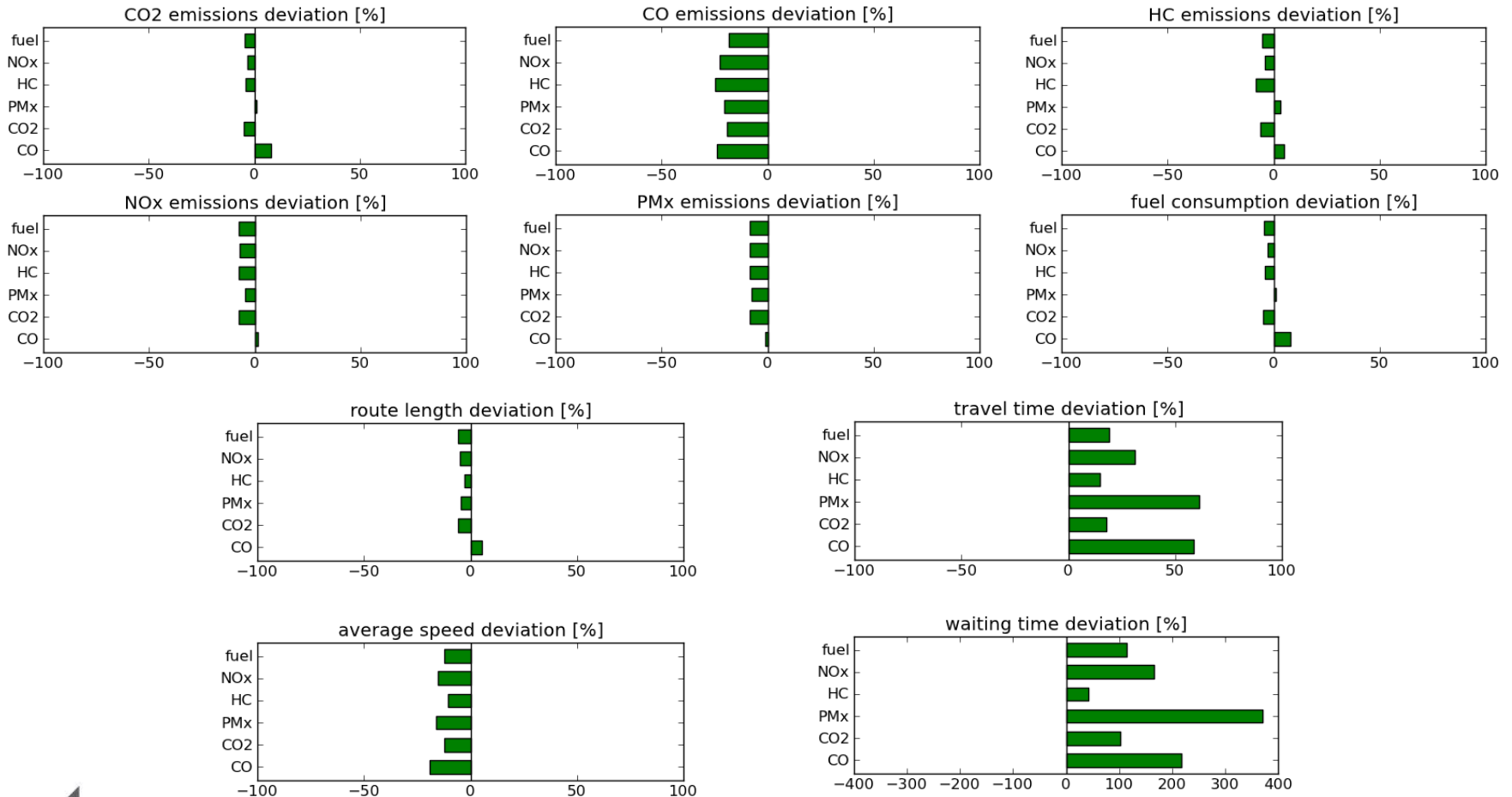
## Comparison against conventional routing

Deviation of the results for routing using the name pollutant from conventional routing using travel time



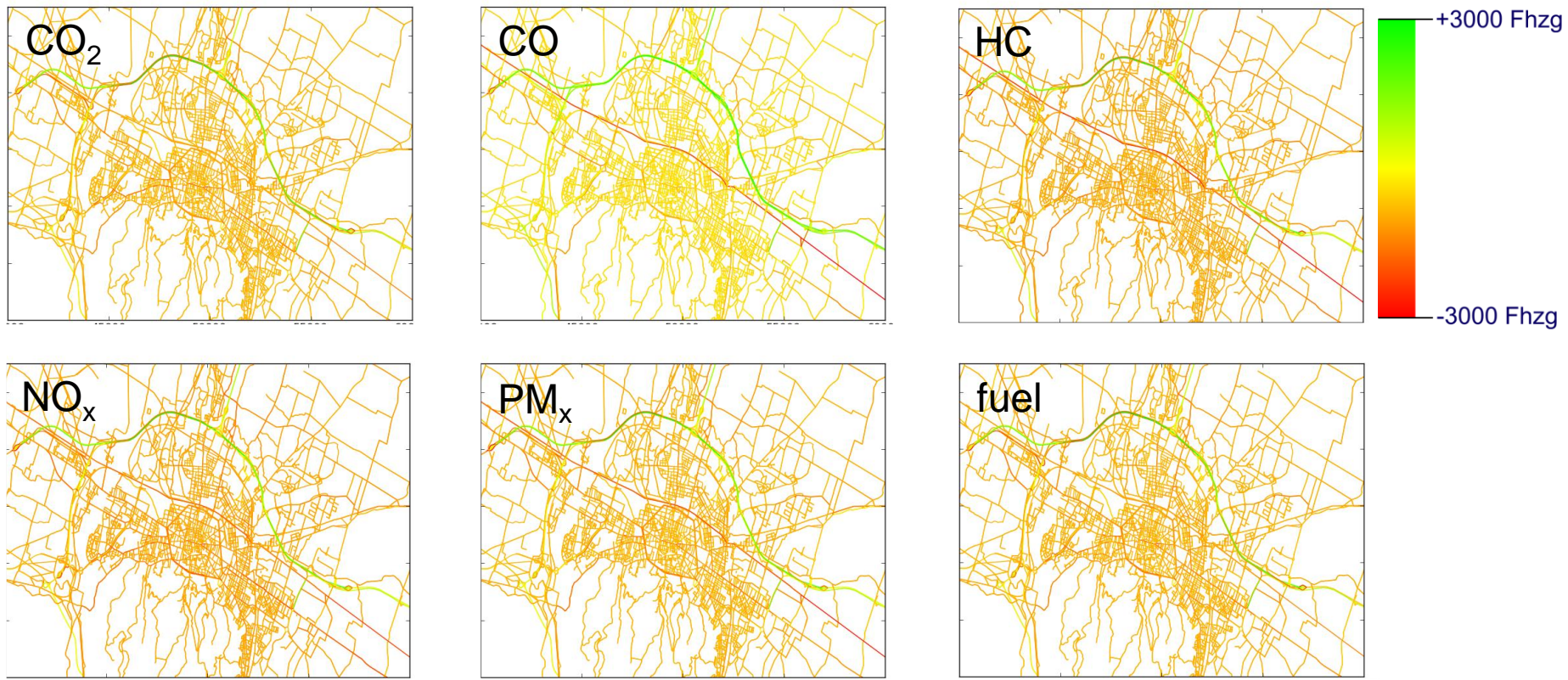
# Results

## Comparison against conventional routing



# Results #2

## Road Usage



# Conclusions

- Computation of a dynamic user assignment using pollutant emission does work
- The per-participant reduction also yields in an overall, system wide reduction of the pollutant against which routes are optimized
- But: a shift to shorter routes takes place; more vehicles are entering the city and exhaust more pollutants there



# Thank you for your attention!

We want to thank the European Commission for co-funding the iTETRIS project where this research has been done.

For more information about SUMO (“Simulation of Urban MObility”) visit <http://sumo.sf.net>

