

# Modelling Fire Incidents Response Times in Ålesund

R. Bergmann, J. Christmas, J. Rebenda, S. Singh, A. Zhakatayev

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# Introduction

There are 2 full time and 15 part time operated fire stations in Ålesund.

By law they are required to respond

- ▶ 10 minutes to
  - ▶ Hospitals
  - ▶ Nursery Homes
  - ▶ industrial areas
  - ▶ high spreading risk areas
- ▶ 20 minutes to residential areas
- ▶ 30 minutes to anything else

## **Goal.**

Build a map (“heat map”) illustrating zones that are reached in 10 (20,30) minutes from the fire stations.

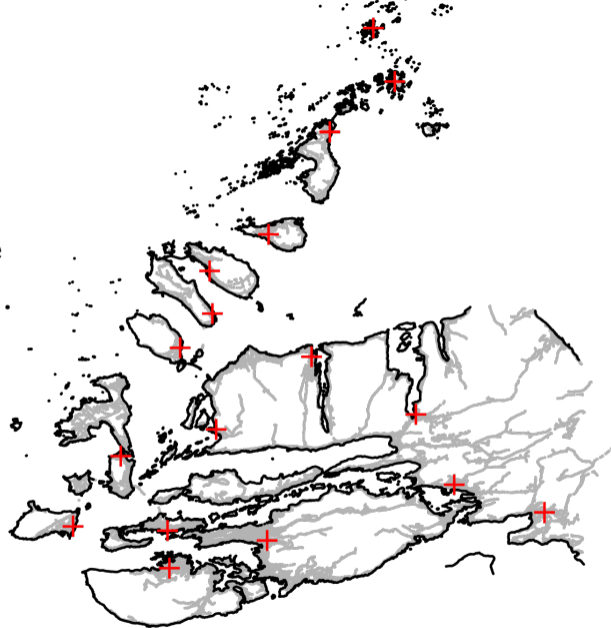
# Data

- ▶ OpenStreetMap provides
  - ▶ roads, bridges, tunnels
  - ▶ speed limits
  - ▶ objects under construction
  - ! OSM export: 251 MB .xml file  
(all data from area)



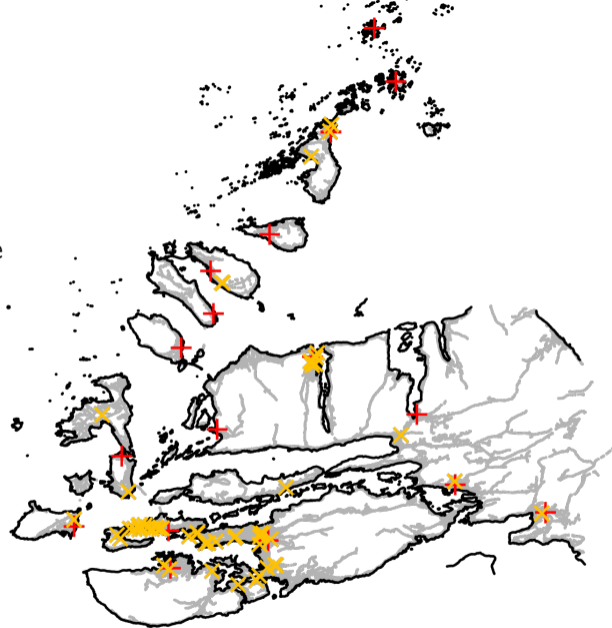
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  - ▶ (part & full time) **fire stations**
  - ▶ 55 “10-min-objects”
  - ▶ statistic of incidents with
    - ▶ incident location
    - ▶ fire stations sent out
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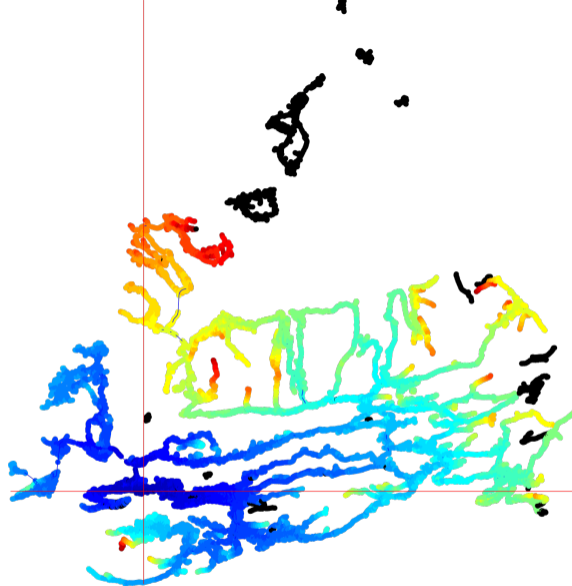
# A Model for the Heat Map

## Approach.

1. convert given data to OpenStreetMap nodes
2. Haversine function to convert latitude and longitude to distances on a plane
3. convert street lengths and speed limit to a travel time per street  
⇒ we obtain a “street graph”
4. for each fire station:
  - ▶ value at station to 0 minutes (5 minutes for part time)
  - ▶ use Dijkstra’s algorithm to compute heat map
  - ⇒ response time estimate for every node in the street graph
5. compute minimum over all fire stations to get response time estimate

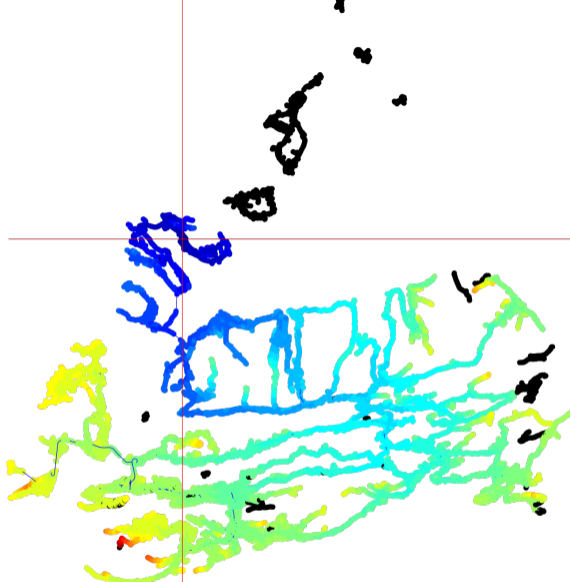
**Challenge.** Ålesunds street graph 125 904 nodes and 242 806 edges.

# Results



Heatmap of Ålesund main fire station

# Results



Heatmap of Flemsøy/Skuløy fire station, 5 minutes offset for part time stations.



# Results



Heatmap of Spjelkavik fire station

# Results



10 (green) 20 (orange) 30 (red) zones for Spjelkavik

# Results



10/20/30 minute zones for the two full time stations

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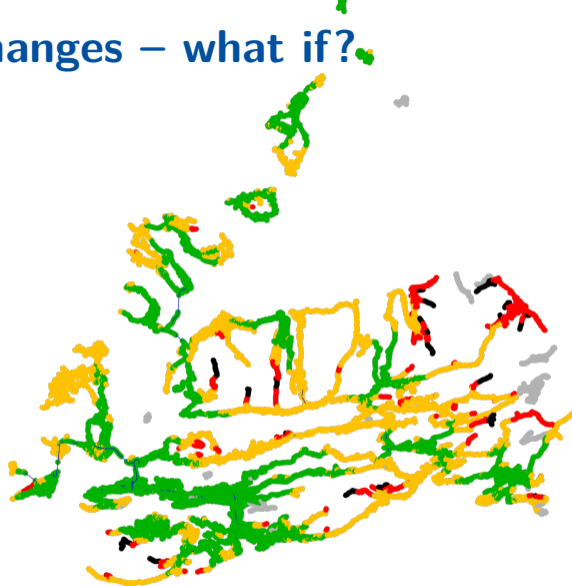
10/20/30 minute zones for all but island stations

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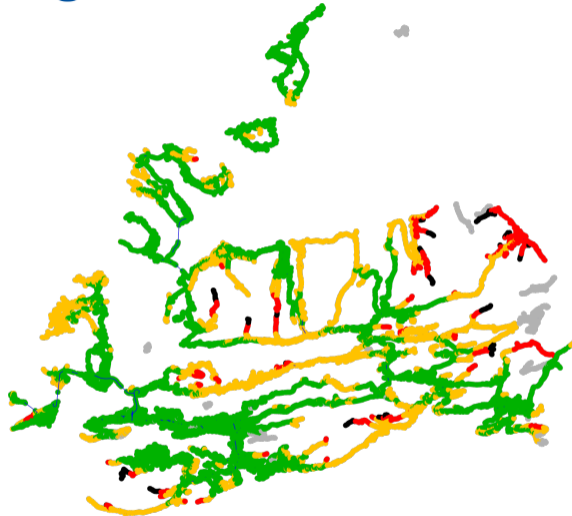
10/20/30 minute zones for all fire stations

# Simulating changes – what if?



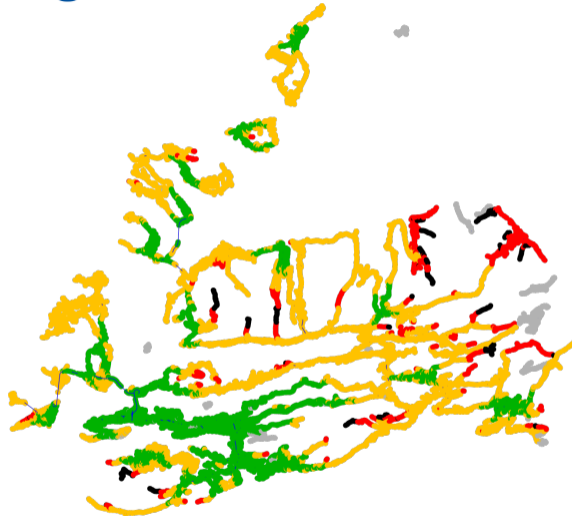
Offset for part time fire fighters set to 5 Minutes

# Simulating changes – what if?



Offset for part time fire fighters set to 3 Minutes

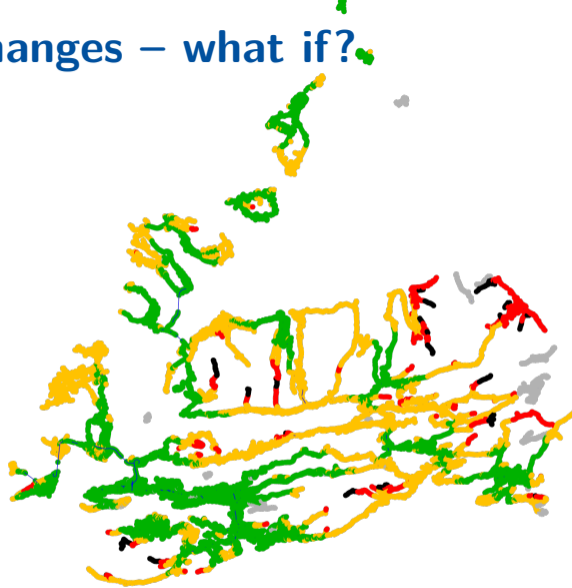
# Simulating changes – what if?



Offset for part time fire fighters set to 7 Minutes

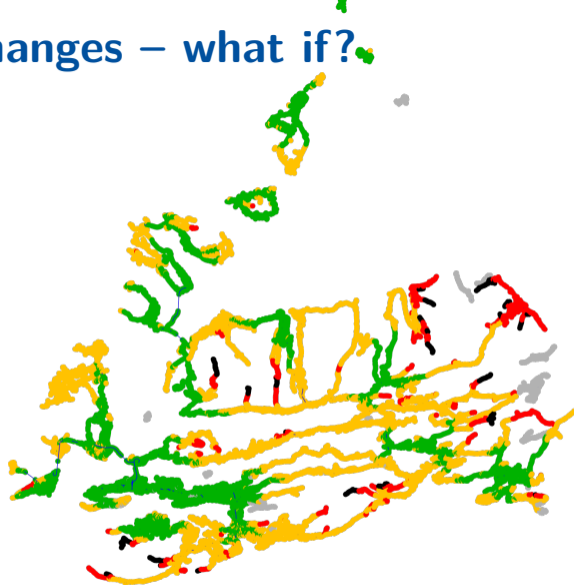


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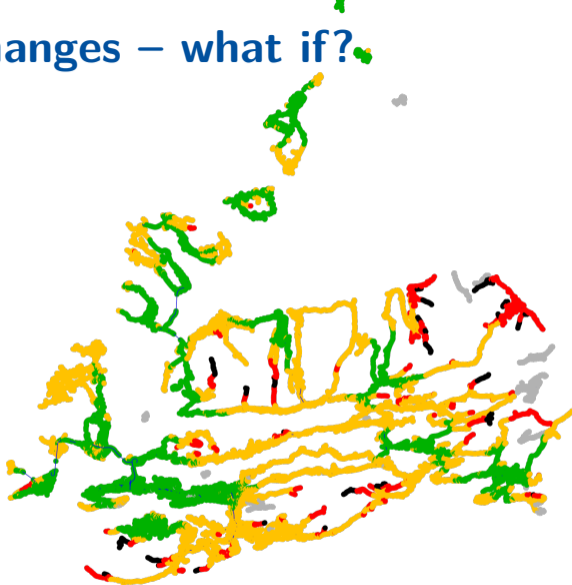
The original scenario again

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10/20/30 minute zones for Spjelkavik part time station

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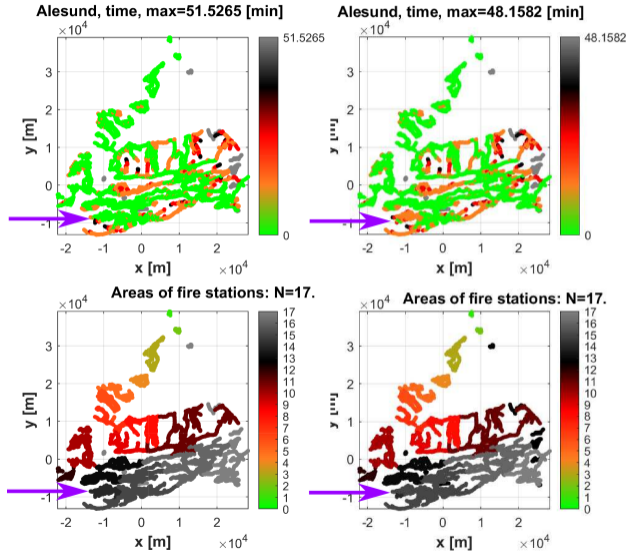
10/20/30 minute zones for Spjelkavik closed.

## What if... – Spjelkavik statistics

For the last scenarios it is interesting to look at the stats with the 55 important 10-minute objects

	current	part time operation	closed
objects not reached in time	14	16	28
maximal time	14.6	18.1	18.4

# What if...interactively



# Further considerations I: Speed Limits

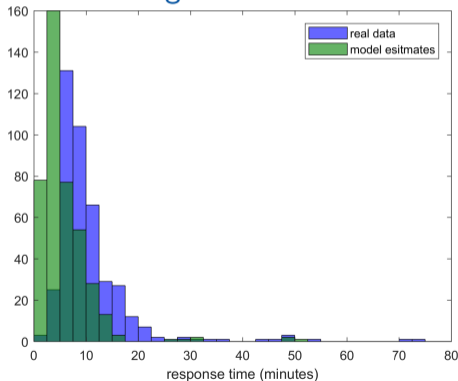
One could further consider

- ▶ rush-hour versus non-rush-hour traffic
- ▶ building a network of electronics that allows
  - ▶ the fire trucks to go faster (“green wave”, e.g. in Hamburg)
  - ▶ flexibility of speed limits
  - ▶ to inform informs drivers about the situation ahead  
(like e. g. in Kristiansand)
- ▶ summer versus winter time

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We can adapt the times if on average our simulation is

- ▶ slower  $\Rightarrow$  Reduce time (increase speed limit) on that street  
They probably can go faster than speed limit here
- ▶ faster  $\Rightarrow$  Increase time (reduce speed limit) on that street  
Maybe there is usually more traffic or the road is steeper



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**Challenge.** Since one iteration of the response times graph takes about one hour, doing optimisation (even Nelder-Mead) would be quite time consuming

# Summary & Conclusion

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- ▶ first checks comparing to real response times
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## Challenges.

- ▶ computation times
- ▶ optimality criteria
- ▶ maybe some more UI/UX