

Master Thesis:

# Urban Air Pollution Inference: A Neural Network Ensemble Approach

**Motivation:** Over the past five years, a mobile sensor network was installed on top of trams in the city of Zurich to perform air quality measurements (Fig. 1(a)). Annotation of measurement data along the tram lines with geo-referenced information (GIS data) about factors that have an impact on air pollution (*e.g.* traffic and industrial activities, density, and height of buildings) allows pollutant concentration inference. Based on these data, land-use regression (LUR) model has been proposed to produce accurate pollution maps with high spatiotemporal resolution (Fig. 1(b)). LUR models use a set of explanatory variables (land-use and traffic data) to model pollution concentrations at locations not covered by the mobile sensor nodes. However, the LUR model has two drawbacks:

- It can only generate air pollution maps at semi-daily temporal resolution with high accuracy.
- It outputs no information on the uncertainty of the inferred air pollution concentration.

**Approach:** Neural networks may improve the temporal resolution of urban air pollution maps by modeling the non-linearity between air pollution and land-use data. Particularly, an ensemble of neural networks has the advantage of *(i)* often outperforming any individual neural network and *(ii)* indicating the variance of the output.

**Task:** The goal of this thesis is to design and implement an air pollution map generation method based on neural network ensembles to improve the temporal resolution of air pollution maps and provide uncertainty values for the inferred pollution concentration. This involves for you the following tasks:

- Design and implement a neural network ensemble to generate air pollution maps for Zurich (mainly ozone and ultra fine particle).
- Evaluate the performance of the ensemble approach on the OpenSense dataset.
- Propose methods to quantify the uncertainty of the air pollution map based on information from the neural network ensemble.

OpenSense web page: [www.opensense.ethz.ch](http://www.opensense.ethz.ch)

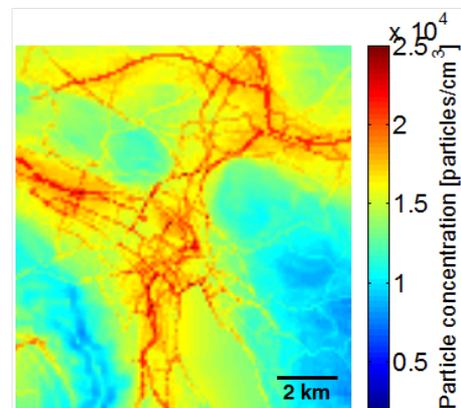
**Requirements:** Knowledge and programming skills on statistics, data analysis and neural networks.

## Contacts

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(a) Sensor box on top of trams.



(b) Fine-grained pollution map.

Figure 1: Ultra fine particle map generated by LUR using sensor measurements and land-use data.