

Robust, Scalable Sequential Monte Carlo with Application to
Urban Air Quality
April 2020–March 2023

Theo Damoulas & **Adam M. Johansen**

Email: a.m.johansen@warwick.ac.uk

[https://www.turing.ac.uk/research/research-projects/
robust-inference-air-quality-monitoring](https://www.turing.ac.uk/research/research-projects/robust-inference-air-quality-monitoring)

Sustainable Cities GRP: UN World Cities Day
31st October 2019

Goals (of EP/T004134/1)

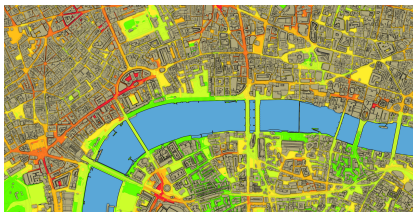
[https://www.turing.ac.uk/research/research-projects/
robust-inference-air-quality-monitoring](https://www.turing.ac.uk/research/research-projects/robust-inference-air-quality-monitoring)

- ▶ To develop methodology to allow:
 - ▶ Fusion of observations from disparate sensor networks: different spatial and temporal scales.
 - ▶ Incorporate information from other sources.
 - ▶ Statistical modelling to allow estimation and prediction of pollutant¹ models *and attendant uncertainty*.
 - ▶ Scale methodology up to allow full uncertainty quantification on city-scale models.
- ▶ To apply this methodology in liaison with the GLA.
- ▶ To make a high quality software implementation available.
- ▶ Utilize the above, for example, in route planning.

¹Including PM2.5, PM10, CO, NO₂ and O₃.

Starting Point 1: London Air Quality Project I

<https://www.turing.ac.uk/research/research-projects/london-air-quality>



Sensors:

- ▶ 100 sensors: 5 pollutants every 15 minutes
- ▶ 1,100 provide NO₂ measurements at monthly intervals
- ▶ Satellite-derived measurements at hourly resolution for NO₂ at lower spatial resolution

Other information: weather, traffic flows, construction activity and street "canyons" . . .

Variational approaches to approx. inference via Gaussian processes.

The main challenges of this work are:

Starting Point 1: London Air Quality Project II

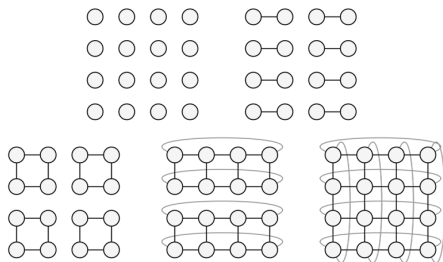
<https://www.turing.ac.uk/research/research-projects/london-air-quality>

- ▶ To ensure that data from a wide range of networks can be brought together to a single place for analysis
- ▶ To bring data into air quality models from a range of quality of sensors
- ▶ To ensure that we monitor the effectiveness of the different interventions planned across London
- ▶ To present the best estimates and forecasts in a way that app and web developers can then use to inform Londoners
- ▶ To accurately find low pollution routes for Londoners to follow when walking, cycling or running through the city

Starting Point 2: Statistical Methods

<https://www.turing.ac.uk/research/research-projects/sequential-sampling-methods-difficult-problems>

- ▶ Robustness: generalized Bayesian inference.
- ▶ Time series: (generalized) particle filters.
- ▶ Spatial inference: divide and conquer methods:



- ▶ Robust spatiotemporal inference: all of the above + more.

Research Team and Collaborators

Current Team:



Theo
Damoulas



Adam
Johansen

Indirectly: others
from LAQP, RSEM
projects & elsewhere.

Recruiting:

Two PDRAs from April 1st 2020.

Partners:

SUPPORTED BY

MAYOR OF LONDON

Funders:

