The University Of Sheffield.

DAFNI

DAFNI–powered Digital Twin of Sheffield Traffic

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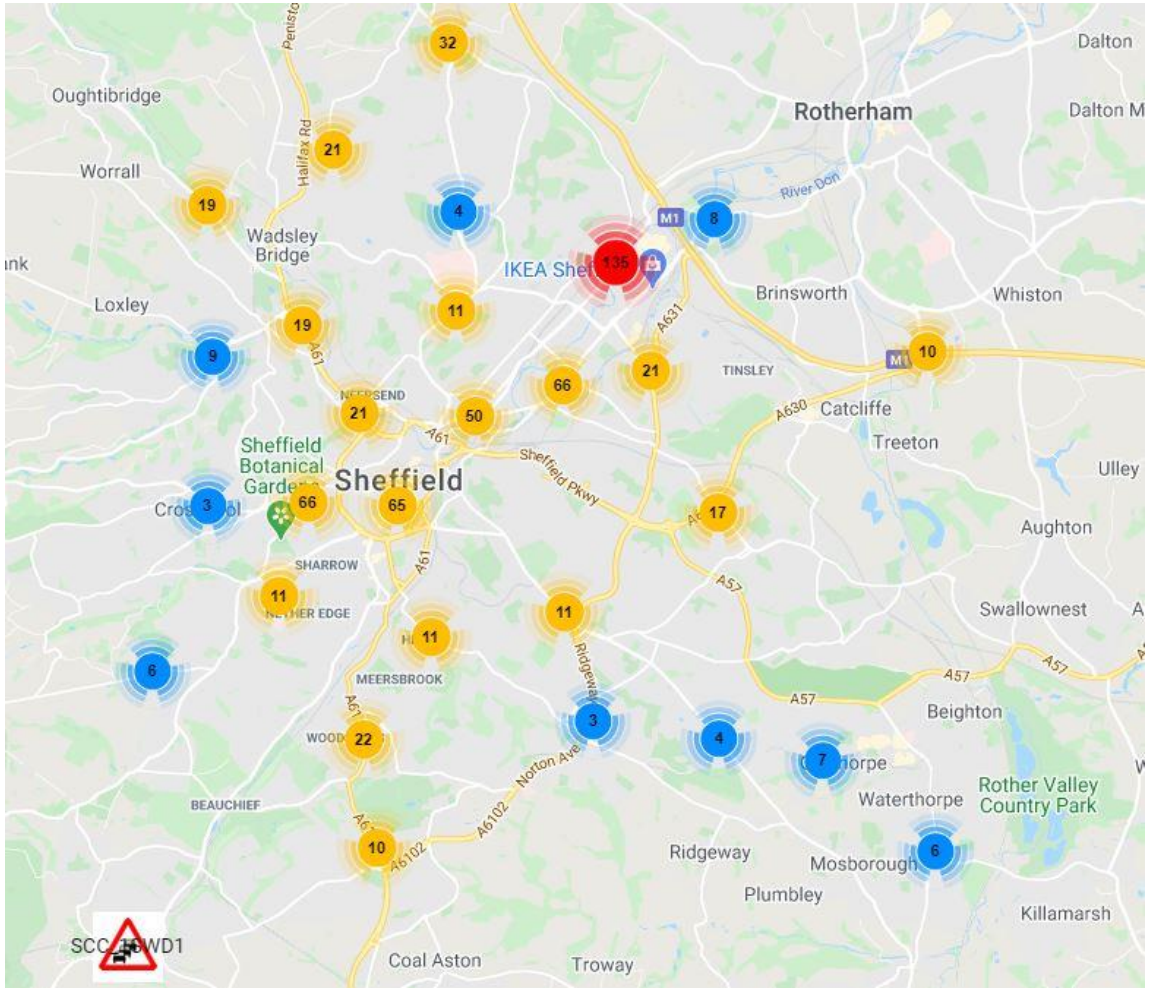
A WORLD TOP 100 UNIVERSITY

Project Aims

- Implement on DAFNI a data-driven model for real-time forecasting of urban traffic to evaluate the platform's capabilities for DT development
- Inform on new functionalities required for full-scale DTs
- Build the foundation for a Traffic DT in Sheffield
  - Create a digital replica of Sheffield's traffic and identify areas where congestion will occur

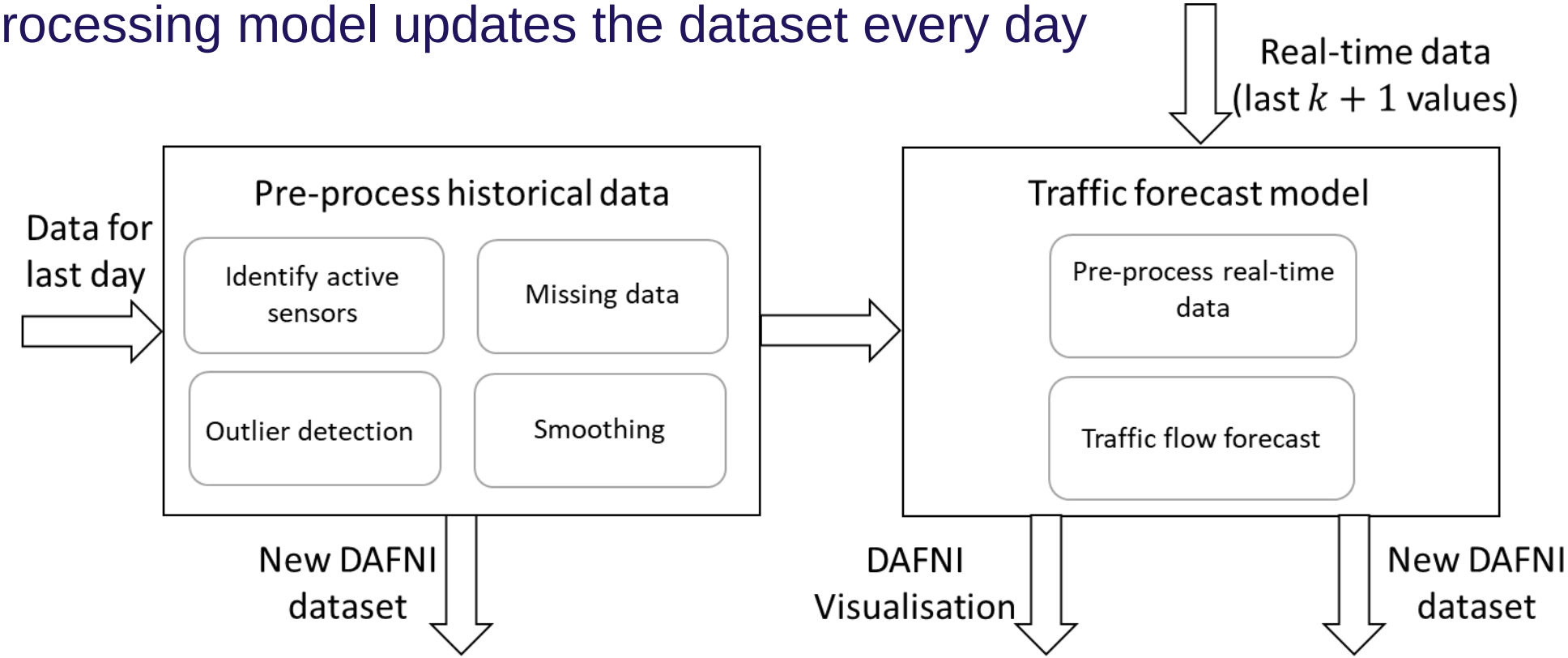
Traffic Sensor Network in Sheffield

- Traffic data:
  - 640 sensors that report traffic flow (no. of cars/min)
  - Time resolution: 5 minutes
  - Data harvested since Sept. 2019
- Available through an API call from the Sheffield Urban Observatory (SUO)
- Pre-processing:
  - Missing data and outlier detection checks
  - Smoothing with 20 minutes moving average window

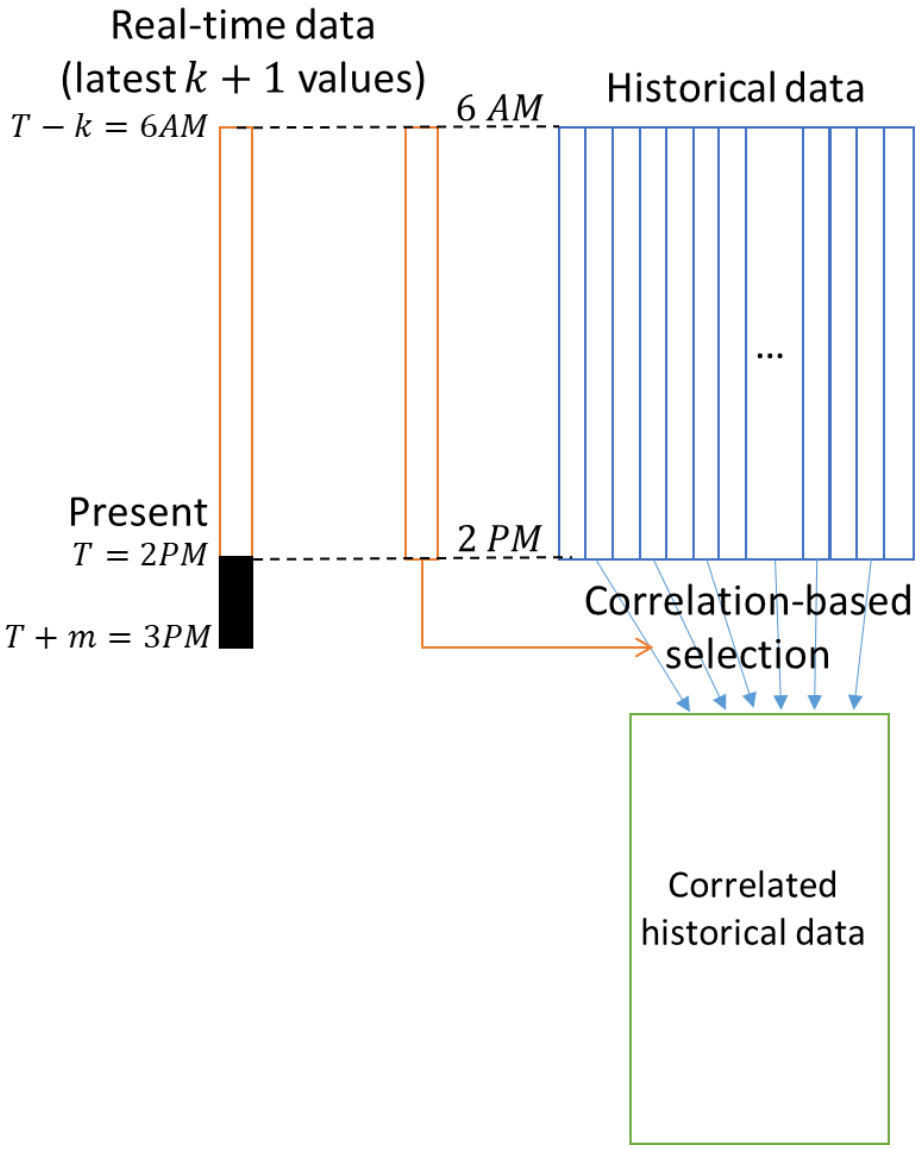


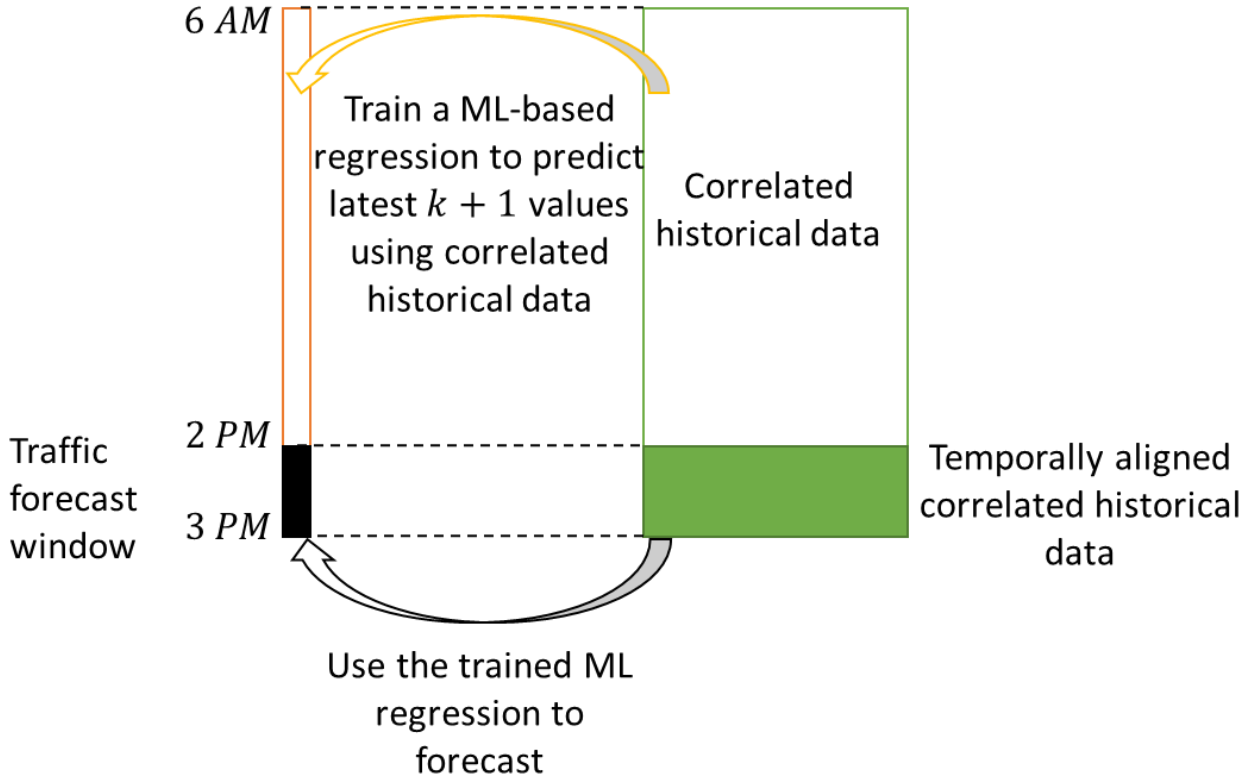
Data

- Data is stored in a matrix format such that each column contains traffic flow values for a particular day and a particular sensor
- Pre-processing model updates the dataset every day



Traffic Forecast Model



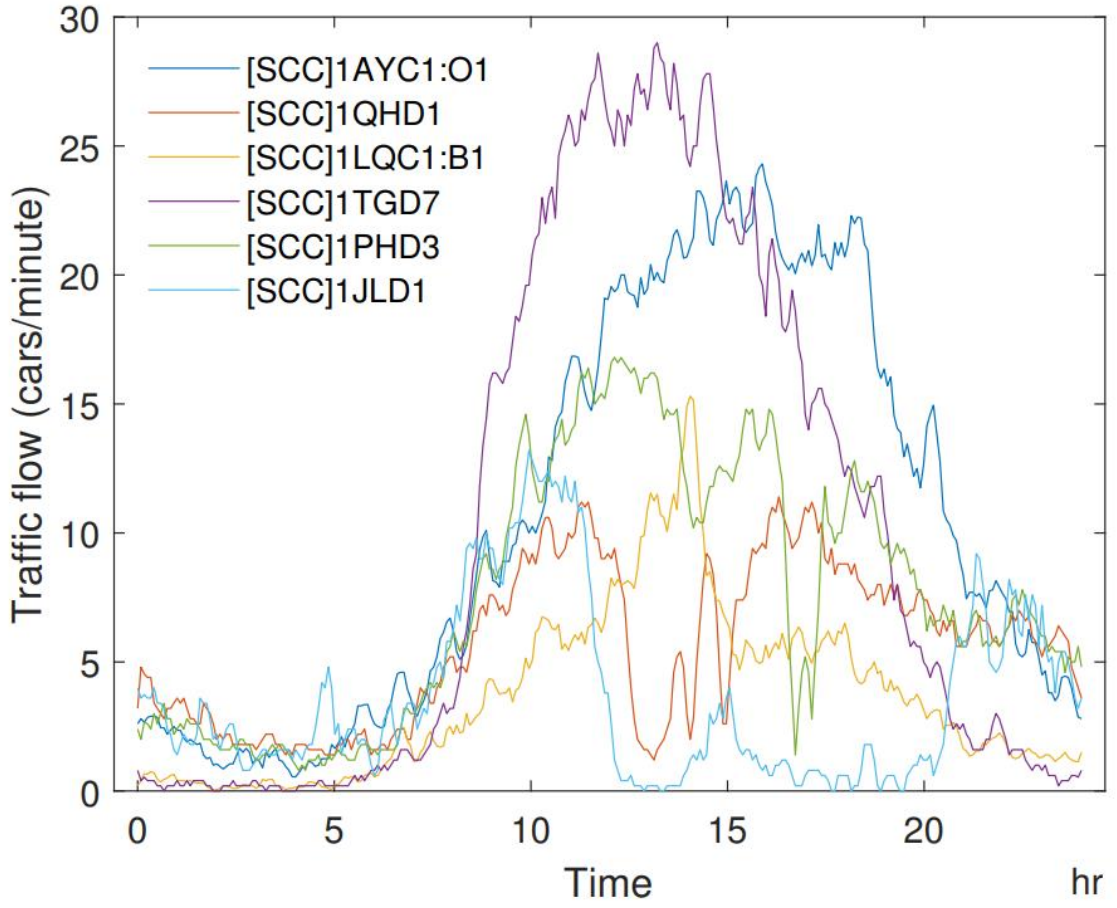


Traffic Forecast Model

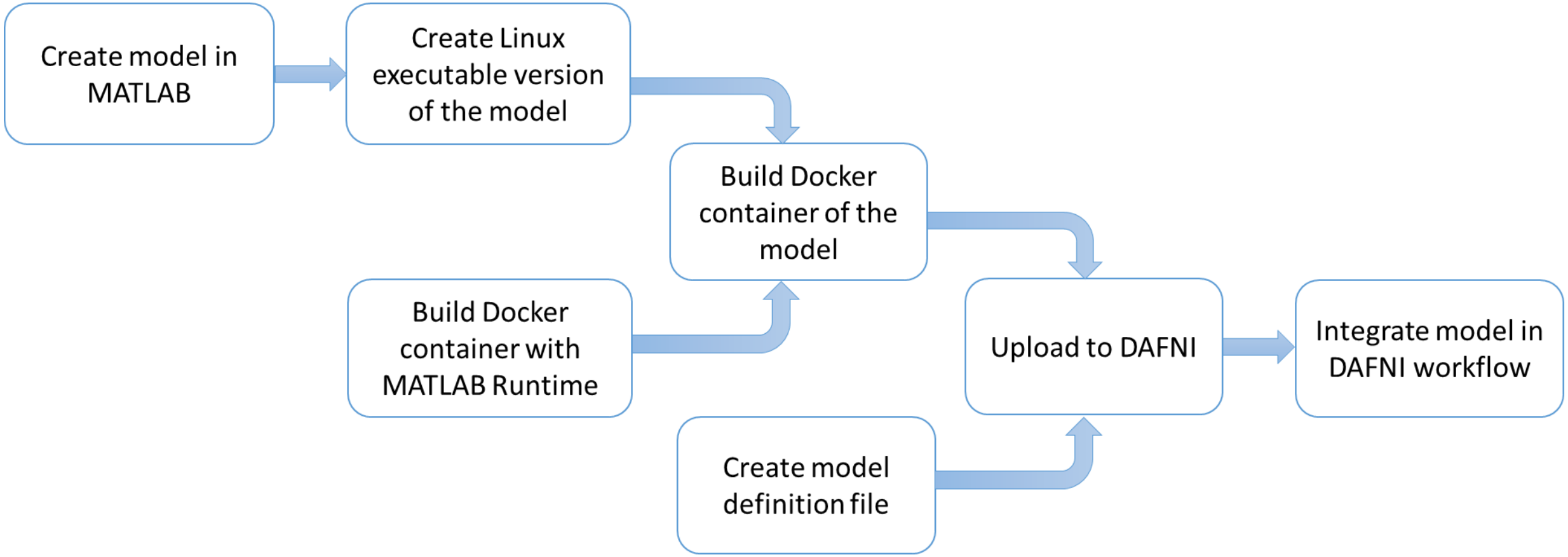
- Benchmarked performance and computational time for: Support Vector Regression (SVR), Gaussian Processes Regression (GPR), Long short-term memory (LSTM) and matrix completion-based algorithm (BSVT)
- GPR gives best performance and lowest computational time (1.2 seconds per sensor)
- DAFNI has the computational power to scale this up by running parallel sessions of the model for all the traffic sensors

Forecast Performance

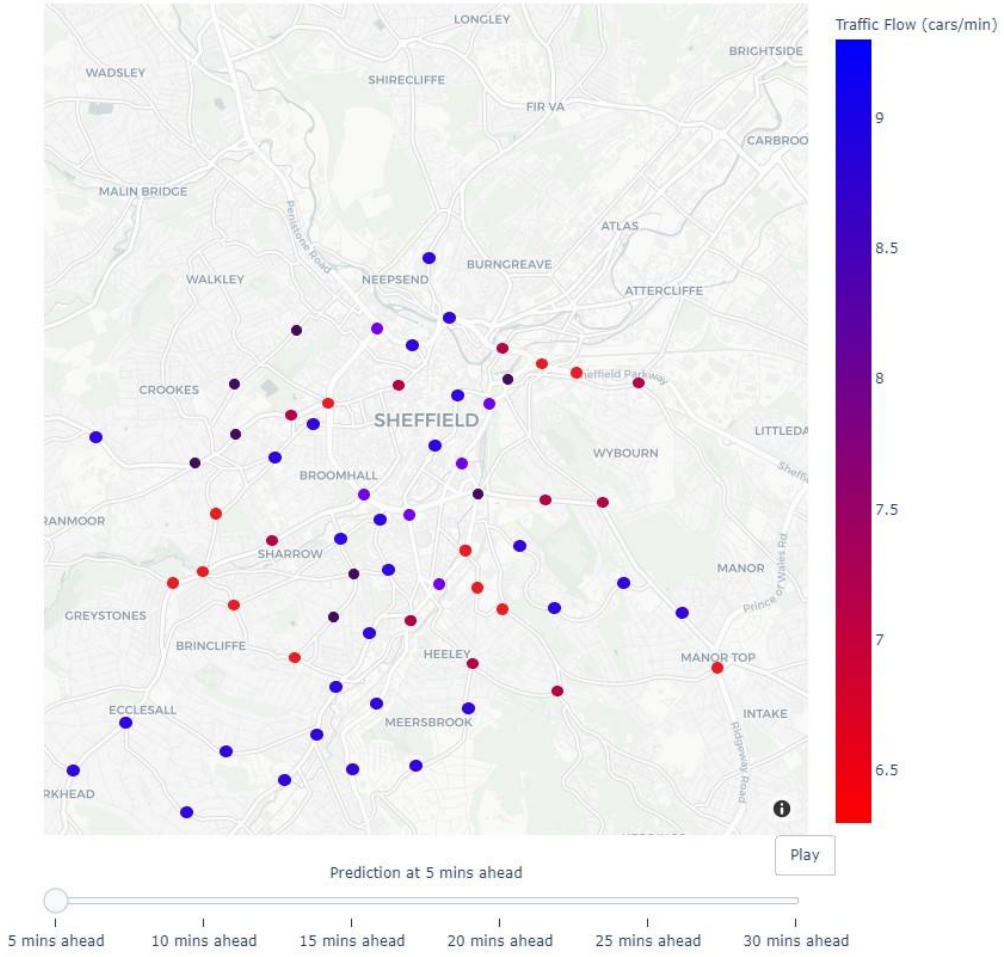
Mean Relative Error over 24-hours		
Sensor id	5 min ahead	15 min ahead
[SCC]1AYC1:O1	7.4%	15.2%
[SCC]1QHD1	13.6%	28%
[SCC]1LQC1:B1	13.9%	24.5%
[SCC]1TGD7	13.2%	28.1%
[SCC]1PHD3	11.2%	20.8%



Model Upload on DAFNI



Visualisation



Future Work

- Scale up the model to calculate predictions (in parallel) for multiple sensors
- Automatically update the pre-processed historical dataset
- Add new types of data (occupancy)
- Integrate the DT in a real-time GUI
  - Update predictions as new data becomes available
  - Focus on regions of interest
  - Create custom output datasets based on user's needs
- Close the loop through interventions (adjust traffic light timing) in areas where congestion is predicted to happen

Acknowledgements

- DAFNI for funding the championship project
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- Patricio from Sheffield Urban Observatory