Even busier than usual: modelling excess congestion on the Strategic Road Network

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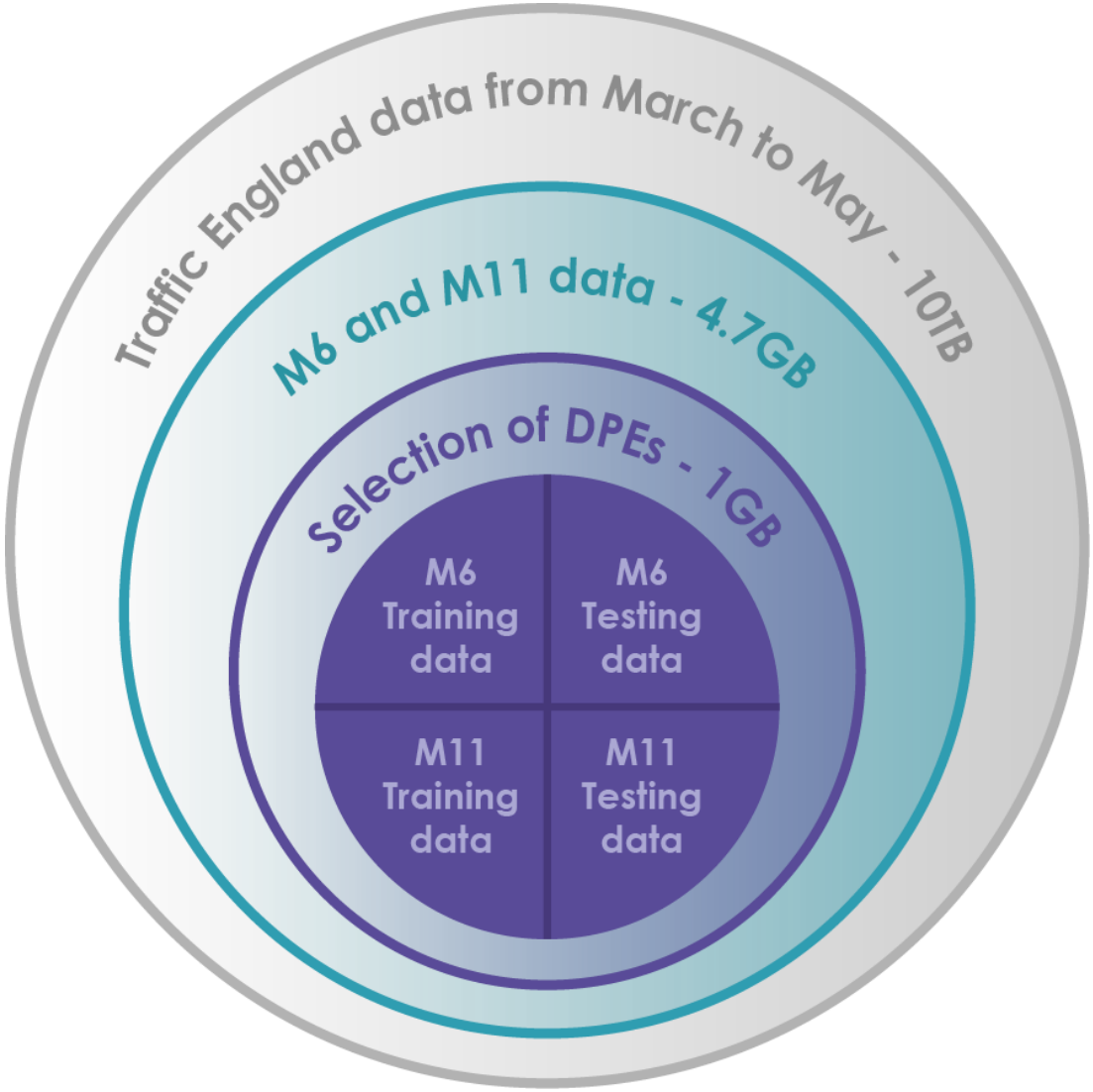
Project Summary

- Processed Data: 10 TB obtained from Higways England.
- Studied Period: March-April-May 2016.
- Studied Areas: Complete M6 and M11.
- Outcome: 5 Proposed models + Null Model.
- Performance: Increased accuracy w.r.t. the original model.

Data Acquisition



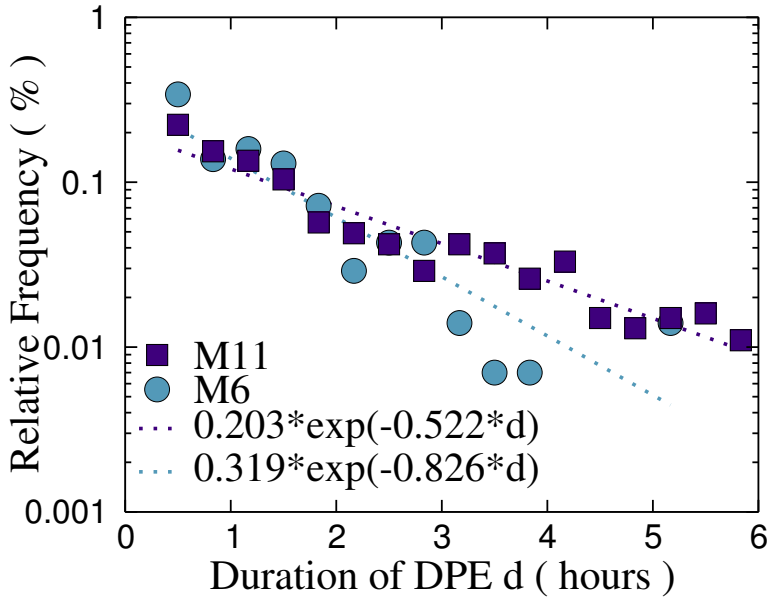
Deviation from Profile Events

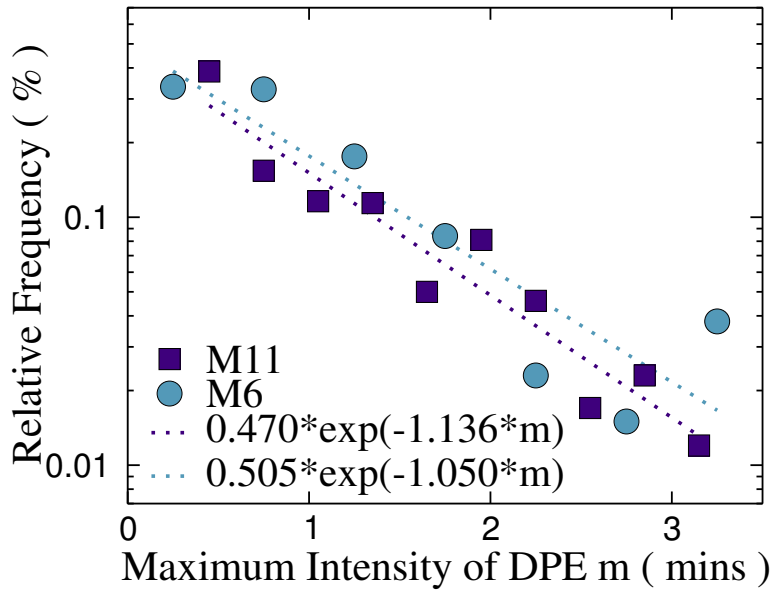
- The continuous exceedance (5 minutes or more) of the profile travel time by a certain threshold.
- Specified by a time series of the Deviation from Profile Intensities x_t:

$$x_t = c_t - p_t - \theta \tag{1}$$

- c_t and p_t are the current travel time and profile travel time respectively, and θ is the threshold.
- θ was chosen to be 6.

Exploratory Data Analysis





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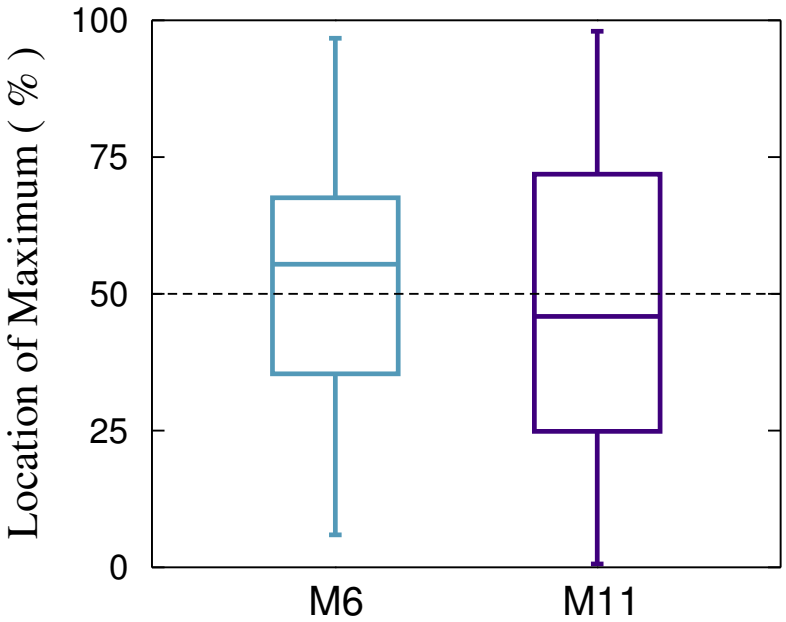
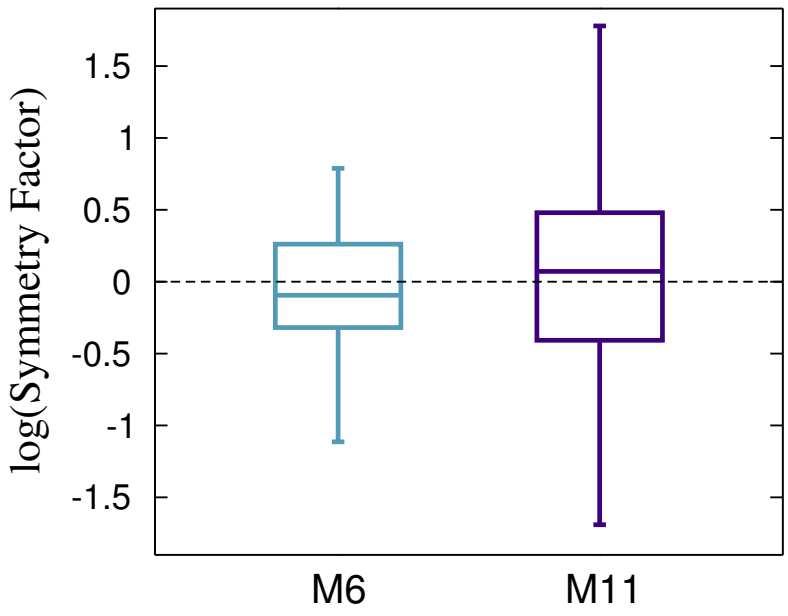




Selection

- Discard any DPE that is shorter than 20 or longer than 360 minutes in duration.
- Only consider events where the maximum x_t is greater than or equal to 20 seconds.
- Smooth the observations using a low-pass filter.

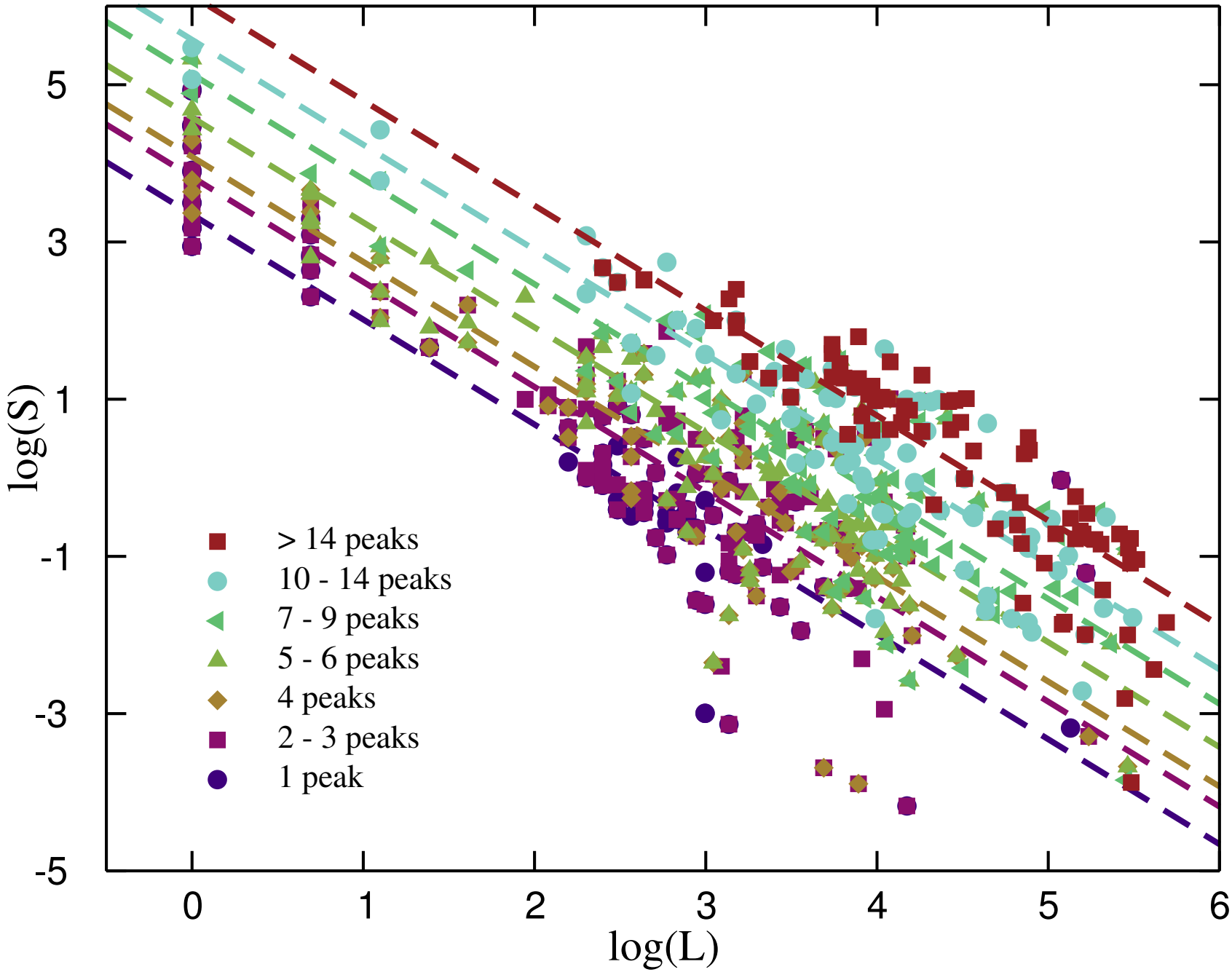
Heuristic Algorithms

- Null Model
- Midpoint Prediction
- Dynamic Trapezium

Other Algorithms

- Linear Regression
- Weighted Multimodel

Linear Model - M11



Scoring

The Average Prediction Error at any percentile of the DPEs is defined as:

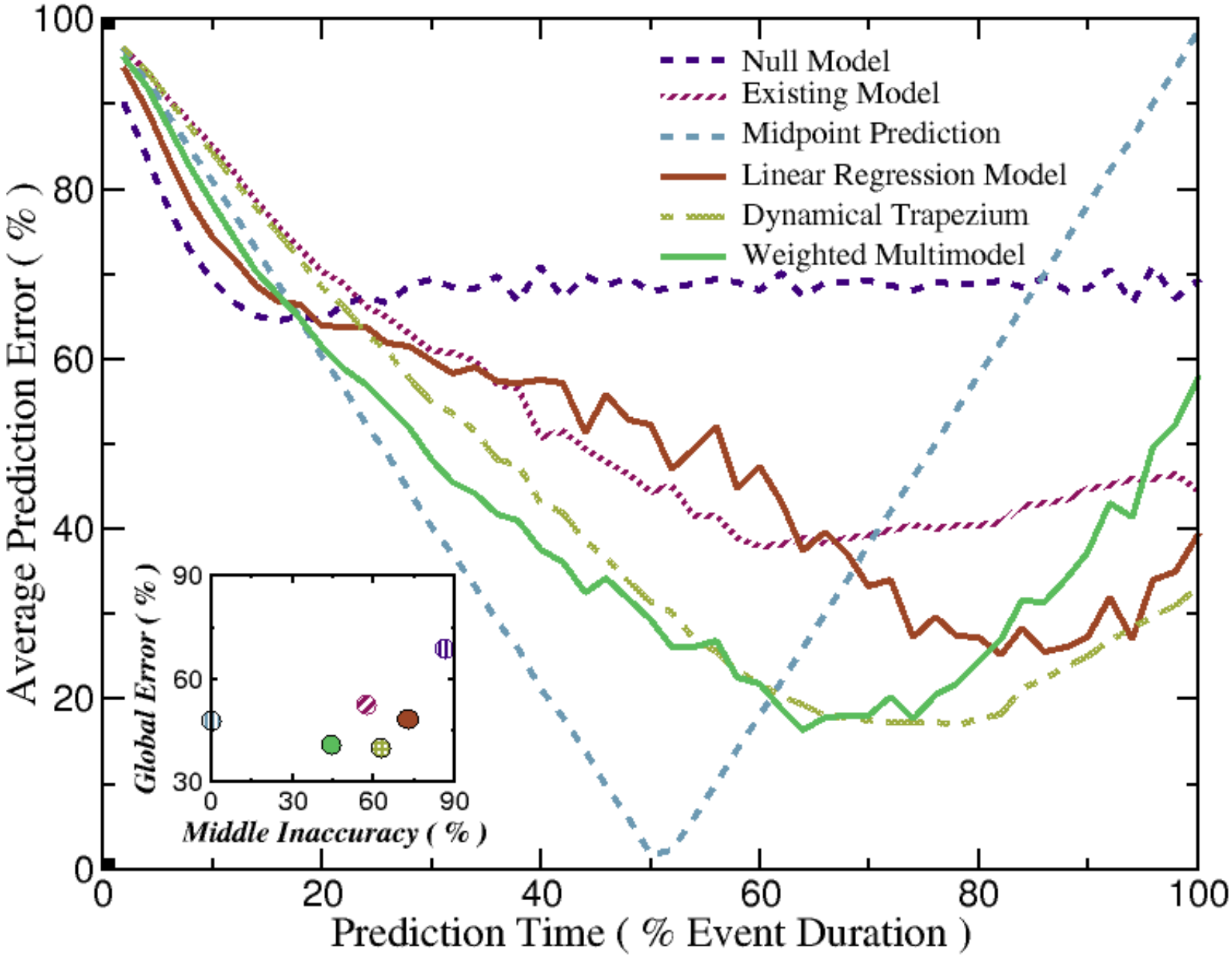
$$E_p = \frac{1}{N} \sum_{i=1}^{N} E_p^{(i)} \tag{2}$$

where $E_p^{(i)}$ is the percentage error at the p^{th} percentile of the duration of the i^{th} DPE. $E_p^{(i)}$ is calculated as follows:

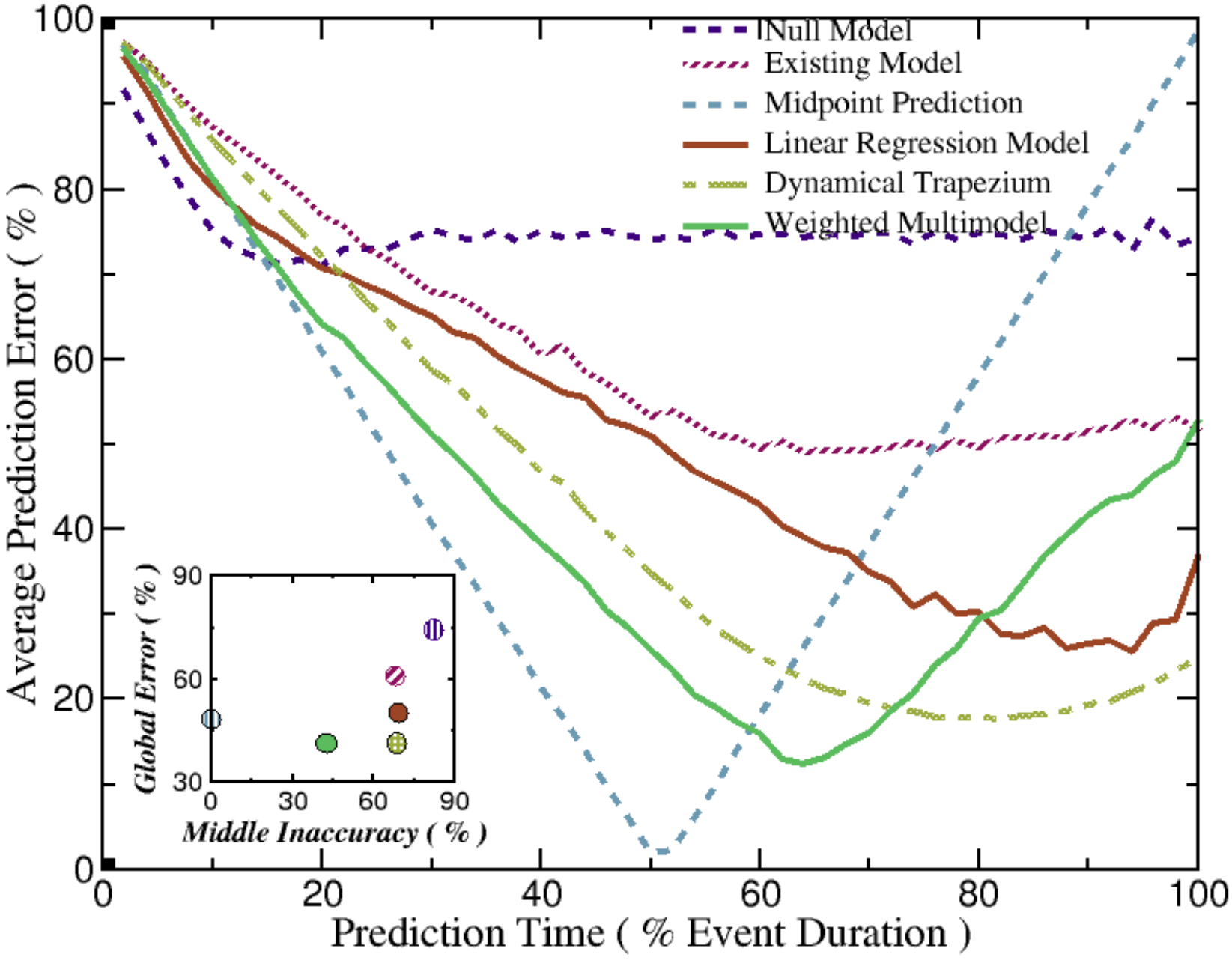
$$E_p^{(i)} = 100 \frac{|y^{(i)} - \hat{y}_p^{(i)}|}{y^{(i)}} \tag{3}$$

where $y^{(i)}$ is the true value of the duration of the i^{th} DPE and $\hat{y}_p^{(i)}$ is the predicted value at the p percentile of the i^{th} DPE.

Results - M6


Null Model
Existing Model
Midpoint Prediction
Linear Regression Model
Dynamical Trapezium
Weighted Multimodel
Average Prediction Error (%)
Prediction Time (% Event Duration)
0
20
40
60
80
100
Global Error (%)
Middle Inaccuracy (%)
30
60
90

Results - M11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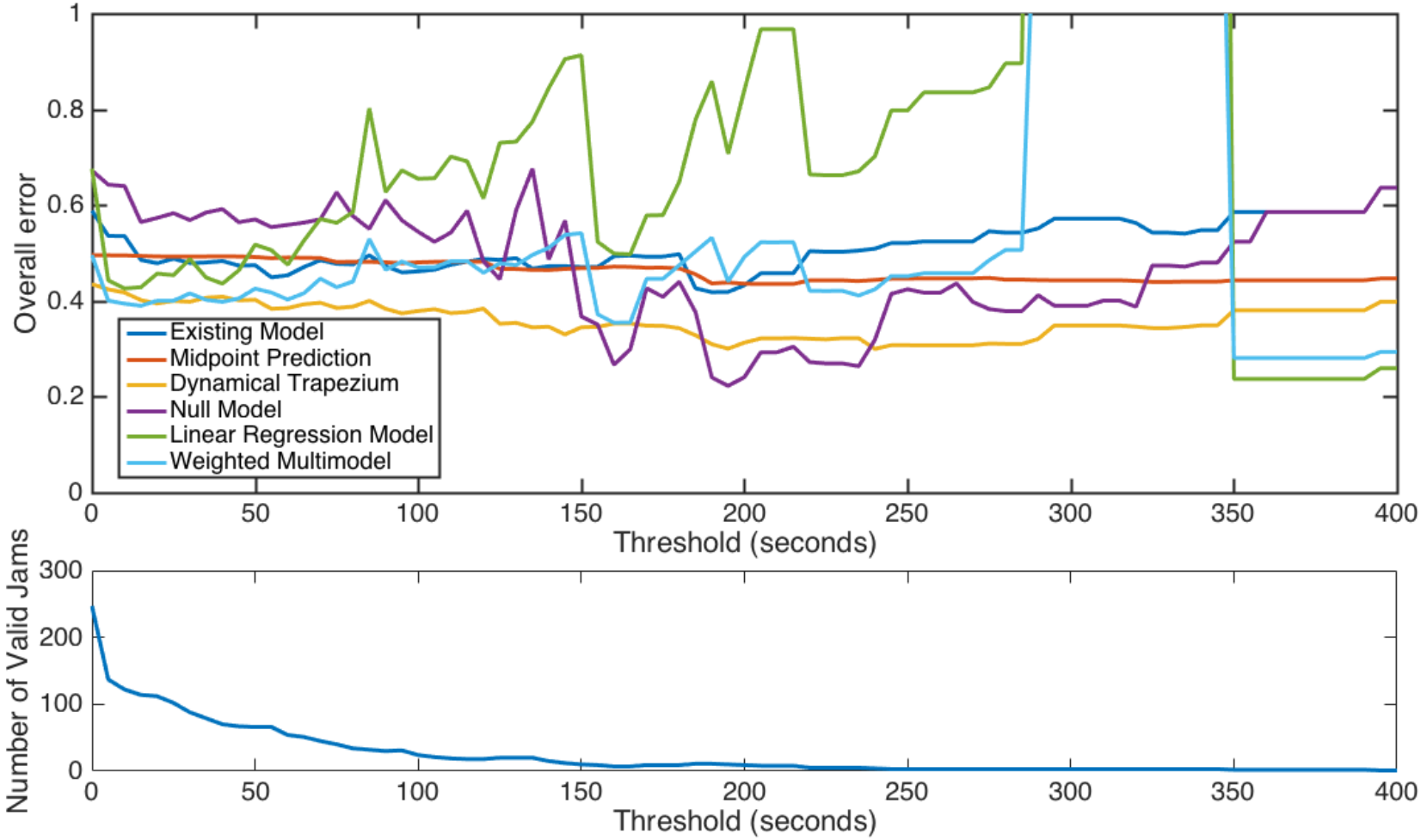
Varying the Threshold - M6

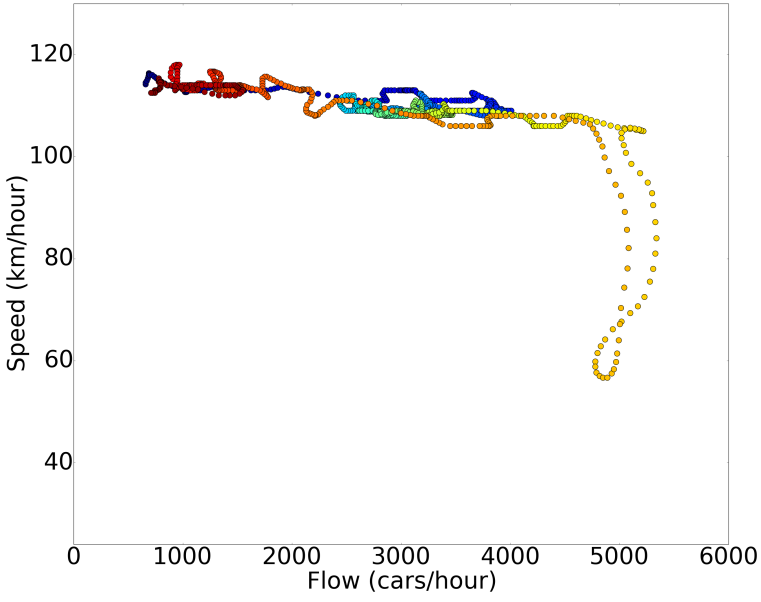


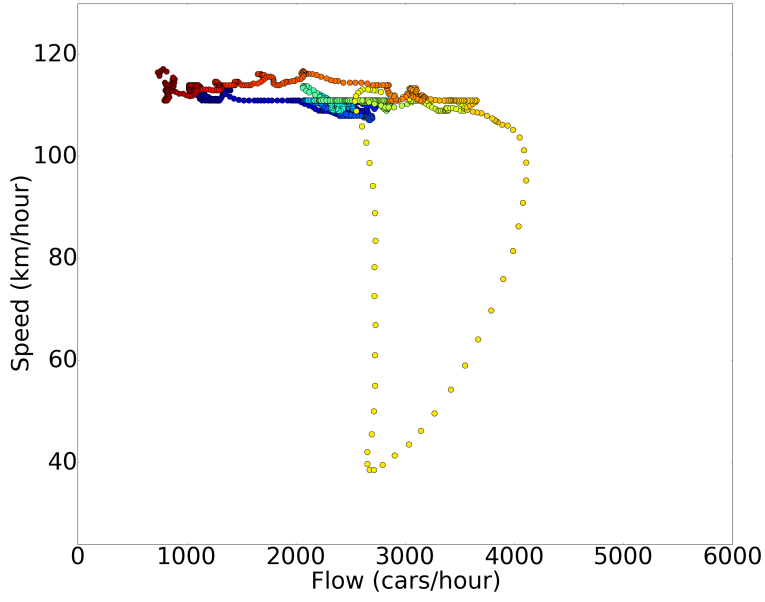
Further Work

- Macroscopic Physical Models, e.g. Fluid Dynamics
- Microscopic Physical Models, e.g. IPS
- Machine Learning, e.g. Hidden Markov Models

Thank you!!!

Speed/Flow Trajectories





Speed/Flow Trajectories

Two trajectories u and v fixed to 100 points each using interpolation:

$$u : \{p_1^u, p_2^u, ..., p_i^u, ..., p_{100}^u\}$$
$$v : \{p_1^v, p_2^v, ..., p_i^v, ..., p_{100}^v\}$$

where a point $p_i^\bullet$ is a coordinate $(flow, speed)$ in the Speed vs. Flow graph. The distance metric developed is denoted by D:

$$D = \frac{1}{100} \sum_{i=1}^{100} ||p_i^u - p_i^v|| \tag{4}$$

Speed/Flow Trajectories