

Identification of Nonlinear Dynamic Relationships

APPLIED TO DIESEL ENGINE EMISSION MODELING

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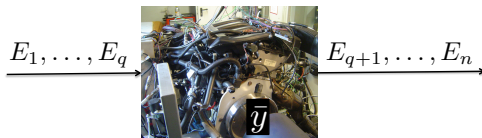
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Modelling Emissions: Problem Statement



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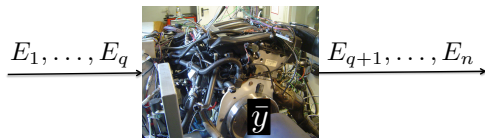
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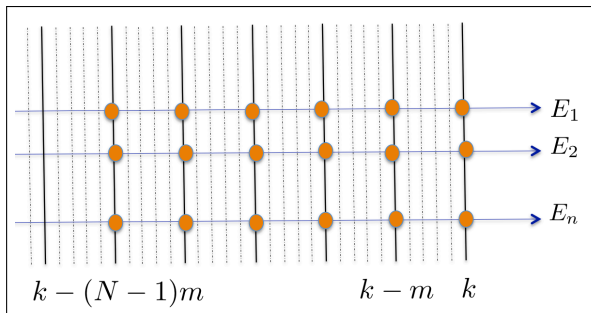
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Find a sampling period, an integer N and a nonlinear map F such that:

$$\bar{y}(k) \approx F(Z(k))$$

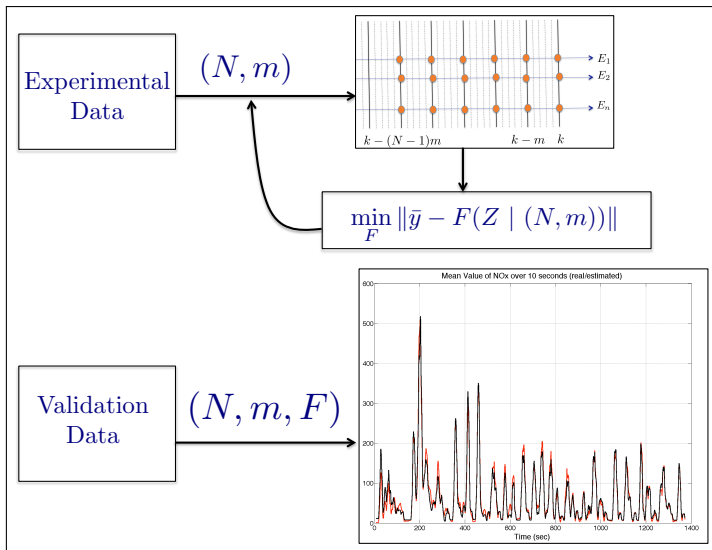
The sampling issue



Under sampling may be used to define the regressor Z :

$$Z(k) := \left(Z(k - (N - 1)m), \dots, E(k - m), E(k) \right) \in \mathbb{R}^{Nn}$$

Solution's Overview



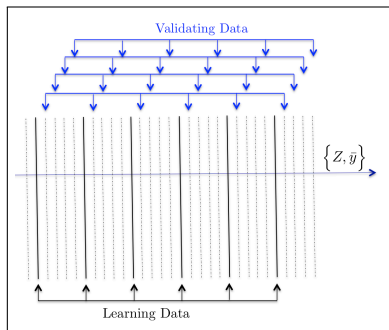
- DATA (LEARNING/VALIDATION)
- PARAMETERS OF THE SOLUTION
- IDENTIFICATION RESULTS

Learning/validation data

- BMW M47TUE Diesel Engine (UJK, Linz Test-Bed)
- Acquisition rate (100 Hz)
- 10 ECU on-line available sensors (Boch)
- ≈ 1371600 samples (23 min)

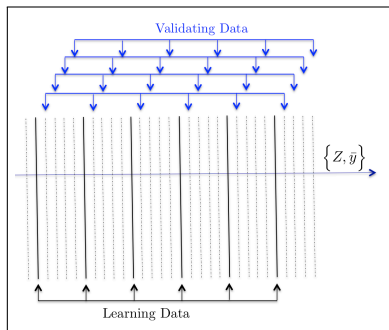
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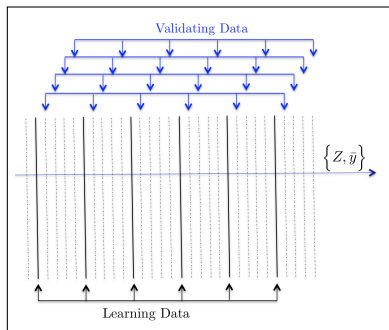
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The learning set is ≈ 100 times smaller than the validating set.

Parameters of the solution

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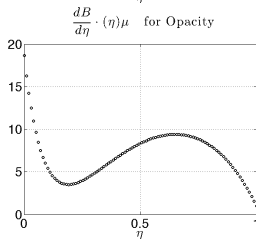
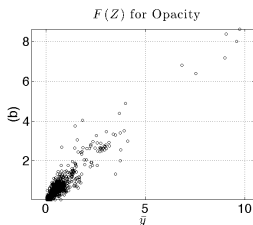
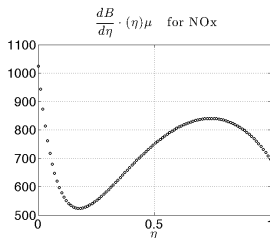
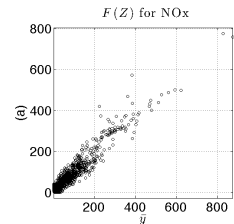
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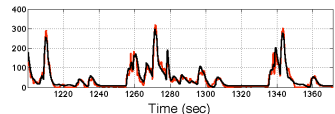
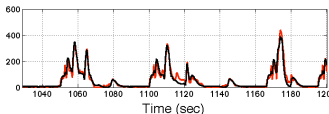
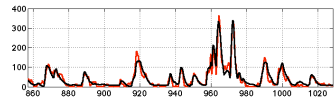
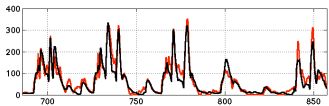
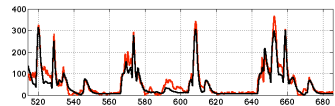
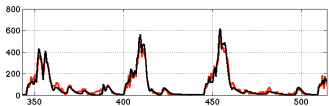
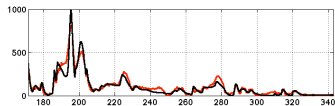
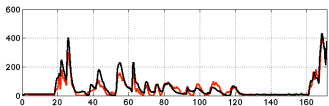
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- **56** parameters and Compression Ratio: $1370000/56 \approx \mathbf{24000}$

Learning Identification Results



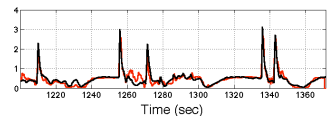
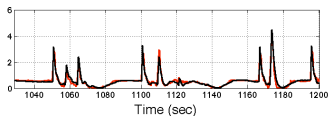
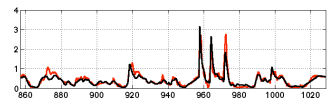
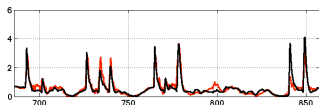
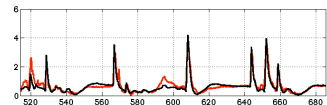
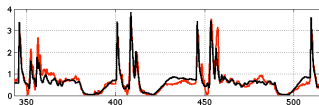
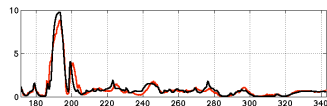
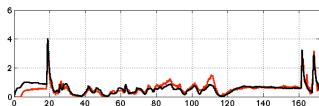
- (a) NOx
- (b) Opacity
- Note the highly nonlinear character of the maps Γ

Validation Identification Results (NO_x)



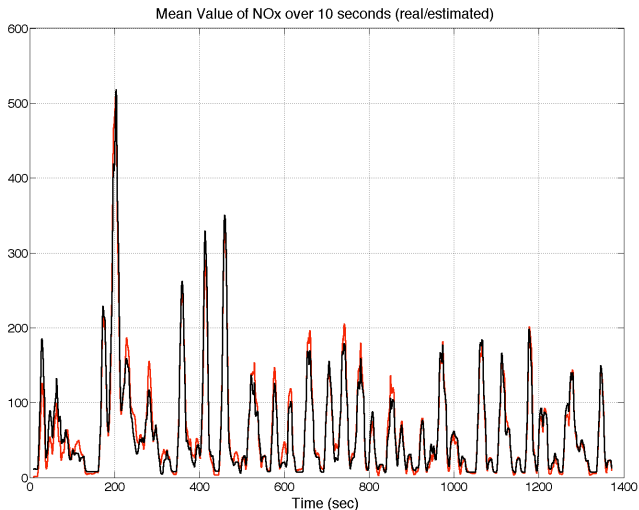
Evolution of NO_x (Model-based prediction/Measured)

Validation Identification Results (Opacity)



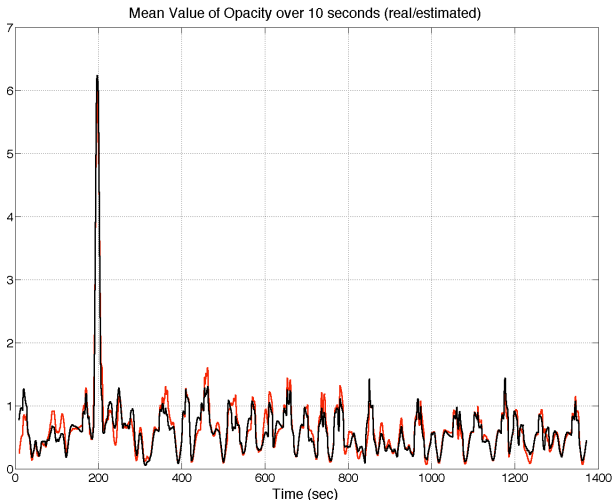
Evolution of opacity (Model-based prediction/Measured)

Validation Identification Results (NO_x)



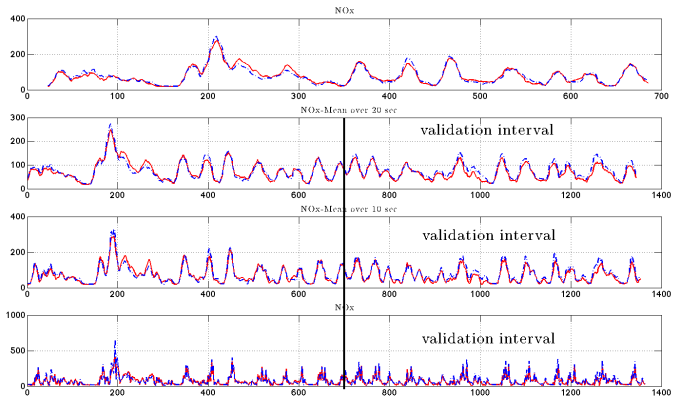
Evolution of NO_x (Model-based prediction/Measured)

Validation Identification Results (Opacity)



Evolution of opacity (Model-based prediction/Measured)

Disjoint learning/validation data (Opacity)



20 seconds mean-NOx validation results