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Variable importance analysis of railway vehicle responses

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In the development process of railway vehicles several requirements considering reliability and safety have to be met. These requirements are commonly assessed by using Multi-Body-Dynamics (MBD) simulations and on-track measurements.
In general, the vehicle/track interaction is significantly influenced by varying, unknown or non-quantifiable operating conditions (e.g. coefficient of friction) resulting in a high variance of the vehicle responses (forces and accelerations). The question is, which statistical methods allow to identify the significant operating conditions to be considered in the simulation?

This paper proposes a methodology to quantify the effects of operating conditions (independent variables) on vehicle responses (dependent variables) based on measurements and simulations. A variable importance analysis is performed considering the nonlinear behaviour of the vehicle/track interaction as well as the correlation between the independent variables. Hence, two statistical modelling approaches are considered. The focus is on linear regression models, which make it possible to include the correlation behaviour of the independent variables in the analyses. Further, random forest models are used to reflect the non-linearity of the vehicle/track interaction.

The variable importance measures, derived from both approaches, result in an overview of the effects of operating conditions on vehicle responses, considering the complexity of the data. Finally, the proposed methodology provides a determined set of operating conditions to be considered in the simulation.

Keywords

Reliability and Safety, Variable importance analysis, Linear regression, Random forest, Railway vehicle responses, Vehicle/track interaction

Special/invited session

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