Non Linear Dimension Reduction of Dynamic Model Output

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Modelica models are more often than not dynamic. However, most advanced mathematical methods for the analysis of numerical models cannot cope with functional outputs. There is therefore a need for efficient dimension reduction of dynamic outputs.

Principal component analysis is a well established method, and can be used to tackle this issue. To do so, the functional output is discretised, and its value at each time step is considered as a random variable. Principal component analysis performs dimension reduction while considering only a given number of new high-variability variables, called *component*. The method however relies on a linear hypothesis that limits its applicability.

The non linear method of auto-associative model overcomes this shortcoming thanks to a different projection index and nonlinear regression functions. Similarly to Principal Component Analysis, only a given number of the new variables formed is selected as "meaningful".

We illustrate both methods on a case study, the well-known bouncing ball. We found out that the auto-associative model requires a lower number of variables than principal component analysis to replicate the behaviour of the model with a low error. Moreover, the variables issued of auto-associative model somehow decomposes the inputs effects. It thus provides physically interpretable data representations.

Keywords: dimension reduction, functional data analysis, FMI, OtFMI, principal component analysis, auto-associative model, sensitivity analysis.

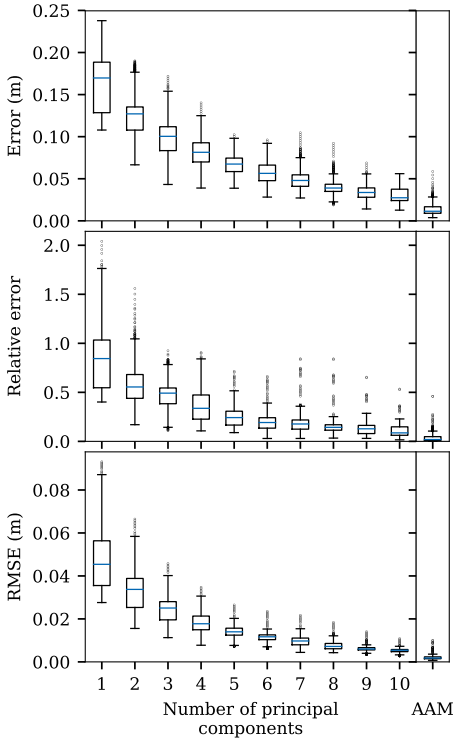

Figure 1. Comparison of the boxplots issued of Principal Component Analysis, with a number of components up to 10, and of Auto-Associative Model, with 1 component.