# Identification and prediction of time-dependent structural behavior with recurrent neural networks for uncertain data

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## Abstract

The long-term behavior of Civil Engineering structures depends on a variety of environmental influences such as applied loadings, temperature and weathering. In general, all time-dependent influences of a structure are uncertain processes which lead to uncertain time-varying structural responses. Uncertain processes can be captured with non-traditional uncertainty models, see Möller and Beer (2008).

For robust design of structures, numerical methods are required which can be used to identify and predict time-dependent material behavior. In this paper, a novel method for the numerical prediction of time-dependent structural responses under consideration of uncertain action processes is proposed, which combines neural computing (artificial neural networks, see e.g. Haykin (1999)) and mapping of fuzzy data (fuzzy analysis, see e.g. Möller et al. (2000)).

Different types of mapping fuzzy processes with recurrent neural networks are introduced. Prediction and training algorithms for the mapping of fuzzy input onto fuzzy output values are described. Thereby, fuzzy network parameters can be considered. Beside fuzzy values, also intervals and deterministic numbers may be processed.

The developed recurrent neural network approach for fuzzy data is verified with a fractional rheological material model, see Oeser and Freitag (2009). The new approach is applied to the prediction of the long-term behavior of textile reinforced concrete structures.

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