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A Deep Learning Approach For Structural Seismic Response Prediction Using Temporal Fusion Transformers

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The dynamic response prediction of bridges under the earthquake is not an easy and straightforward task due to the complexities and uncertainties of loading scenarios and analysis methodologies. Deep Learning (DL) methods have provided a powerful tool for data-driven modeling based on in-situ monitoring data. However, the conventional DL models often do not consider the different inputs commonly present in multi-horizon forecasting and neglect significant static covariates, limiting the scope of application. In this paper, we introduce the Temporal Fusion Transformer (TFT), a novel deep learning method with attention-based architecture that combines high-performance multi-horizon forecasting with interpretable insights into structural seismic response prediction. The TFT model is trained by the dataset of excitation time series and static structural parameters, including the span length, flexural stiffness, and mass per unit length. The proposed TFT model could distinguish the excitation-response interactions of bridges with different construction parameters and make an accurate prediction of earthquake-induced vibration. The dataset of the TFT model is formed by the shared information of bridges, but not the continuous monitoring data of a unique bridge under different earthquakes, which is easy to obtain and improves the feasibility. The performance of the proposed model is demonstrated through numerical examples in terms of root mean squared error (RMSE).