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REDUCING REGRESSION BIAS WITH PHYSICS-INFORMED LSTM NETWORKS

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ABSTRACT

This study examines a physics-informed LSTM-based regression approach for reducing systematic prediction bias in time-dependent learning problems. Common machine learning regression models, such as XGBoost, Random Forest, and standard neural networks, often achieve good average accuracy but show a clear bias pattern by overestimating small values and underestimating large ones, especially when the available data are limited or unevenly distributed. This tendency toward the mean can limit the reliability of regression results in practical applications. To address this issue, the proposed approach incorporates known physical relationships and constraints directly into the training loss, allowing prior knowledge to guide the learning process. The LSTM structure is used to capture temporal dependencies in sequential data, while the physics-based regularization restricts the model to physically meaningful behavior and reduces systematic drift. As a result, the regression model produces more balanced predictions across the full range of the target variable. Numerical experiments on time-dependent regression tasks show that the physics-informed model consistently reduces prediction bias while maintaining comparable accuracy to purely data-driven methods. These results indicate that combining physics-based constraints with LSTM regression offers a simple and effective way to improve prediction reliability when data alone are not sufficient.

Keywords unbiased regression · LSTM · bias correction · PINN · noisy data

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