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REAL-TIME PHASE-RESOLVED WAVE PREDICTION IN THE COASTAL ZONE

William Wright, John Craske, Ioannis Karmpadakis
Imperial College London

Accurate real-time wave prediction is critical for coastal hazard mitigation, navigation safety, and infrastructure resilience. For example, rapid forecasting enables early warning systems for coastal and offshore operations. Traditional theoretical and numerical models, while physically rigorous, are often computationally expensive. This limits their potential in real-time applications. As an alternative, machine learning enables fast and efficient wave predictions while maintaining accuracy.

This study explores a neural network approach to predict wave propagation from deep to shallow water, where nonlinear interactions and breaking introduce modelling challenges. Using a large experimental dataset spanning four bathymetry configurations and varying offshore wave spectra, we train models to predict nearshore surface elevation time series from offshore input (depths from 50m to 10m in field scale). We evaluate multilayer perceptrons, convolutional neural networks, and Fourier neural operators, comparing their ability to predict key wave characteristics such as crest height elevation. Model performance is benchmarked against established real-time wave models across different sea states.

By integrating data-driven methods with traditional wave modelling, this research introduces a robust, real-time forecasting tool for coastal and maritime applications. It is shown that, neural networks offer a computationally efficient alternative to conventional methods, improving decision-making and resilience in coastal environments.