

# **Forecasting functional time series with a new Hilbertian ARMAX model: application to electricity price forecasting**

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**Abstract—** A Functional time series is the realization of a stochastic process where each observation is a continuous function defined on a finite interval. These processes are commonly found in electricity markets and are gaining more importance as more market data becomes available and markets head towards continuous-time marginal pricing approaches. Forecasting these time series requires models that operate with continuous functions. This paper proposes a new functional forecasting method that attempts to generalize the standard seasonal ARMAX time series model to the L2 Hilbert space. The structure of the proposed model is a linear regression where functional parameters operate on functional variables.

The variables can be lagged values of the series (autoregressive terms), past observed innovations (moving average terms) or exogenous variables. In this approach, the functional parameters used are integral operators in the L2 space where the kernels of the operators are modeled as linear combinations of sigmoid functions. The parameters of each sigmoid are optimized using a Quasi-Newton algorithm which minimizes the sum of squared errors. This novel approach allows us to estimate the moving average terms in functional time series models. The new model is tested by forecasting the daily price profile of the Spanish and German electricity markets and it is compared to other functional reference models.

**Index Terms—** Functional Data Analysis, Functional time series, Functional ARMAX model, Electricity price forecasting.

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