

Package ‘WaveST’

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Type Package

Title Wavelet-Based Spatial Time Series Models

Version 0.1.0

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Description An integrated wavelet-based spatial time series modelling framework designed to enhance predictive accuracy under noisy and nonstationary conditions by jointly exploiting multi-resolution (wavelet) information and spatial dependence. The package implements WaveSARIMA() (Wavelet Based Spatial AutoRegressive Integrated Moving Average model using regression features with forecast::auto.arima()) and WaveSNN() (Wavelet Based Spatial Neural Network model using neuralnet with hyperparameter search). Both functions support spatial transformation via a user-supplied spatial matrix, lag feature construction, MODWT-based wavelet sub-series feature generation, time-ordered train/test splitting, and performance evaluation (Root Mean Square Error (RMSE), Mean Absolute Error (MAE), R-squared (R^2), and Mean Absolute Percentage Error (MAPE)), returning fitted models and actual vs predicted values for train and test sets. The package has been developed using the algorithm of Paul et al. (2023) <doi:10.1007/s43538-025-00581-1>.

Encoding UTF-8

RoxygenNote 7.3.1

Imports forecast, stats, neuralnet, tsutils, wavelets

Suggests devtools, roxygen2, usethis

License GPL-3

NeedsCompilation no

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 WaveSARIMA

WaveSARIMA: Wavelet based Spatial ARIMA Model

Description

Builds wavelet sub-series features from lagged original data and spatially transformed data, then fits `forecast::auto.arima()` directly (no grid tuning). Uses wavelet features as regression variables (`xreg`) when they are available/valid.

Usage

```
WaveSARIMA(
  Data,
  Spatial_Matrix,
  Lag = 4,
  Wfilter = "d4",
  Wlevel = 4,
  Split = 0.8,
  y_cols = NULL,
  boundary = "periodic",
  fast = TRUE,
  seed = 123,
  verbose = TRUE
)
```

Arguments

<code>Data</code>	A numeric matrix or data.frame.
<code>Spatial_Matrix</code>	Square numeric matrix used for spatial transform (Bs).
<code>Lag</code>	Integer. Maximum lag used in <code>tsutils::lagmatrix()</code> .
<code>Wfilter</code>	Character. Wavelet filter name passed to <code>wavelets::modwt()</code> .
<code>Wlevel</code>	Integer. Wavelet decomposition level.
<code>Split</code>	Numeric in (0,1). Train ratio for time-order split.
<code>y_cols</code>	Integer vector. Target column indices in <code>Data</code> . Default = 1:k.
<code>boundary</code>	Character. Boundary for MODWT, default "periodic".
<code>fast</code>	Logical. Passed to MODWT; default TRUE.
<code>seed</code>	Integer. Random seed.
<code>verbose</code>	Logical. If TRUE, prints accuracy table.

Value

A list with:

- `model_table`: selected ARIMA orders + AICc + number of regressors used
- `accuracy_table`: train/test metrics per target
- `best_models`: list of fitted `auto.arima` model objects per target
- `predictions`: list of train/test data.frames (Actual vs Predicted) per target
- `error_log`: errors if any target fails

References

Paul, R.K., Yeasin, M. and Manjunatha, B. (2025). WaveDeepCrop: wavelet enhanced deep learning framework for noise-resilient crop yield forecasting. *Proceedings of the Indian National Science Academy*, 91(4), 1310–1323.

Examples

```
Data <- matrix(rnorm(300), ncol = 3)
Bs <- matrix(c(0,1,0,
              0.5,0,0.5,
              0,1,0), nrow = 3, byrow = TRUE)
res <- WaveSARIMA(
  Data = Data,
  Spatial_Matrix = Bs,
  Lag = 4,
  Wfilter = "d4",
  Wlevel = 4,
  Split = 0.8,
  verbose = FALSE
)
res$accuracy_table
```

WaveSNN

WaveSNN: Wavelet based Spatial ANN Model

Description

Builds wavelet sub-series features from lagged original data and spatially transformed data, then fits and hyper-tunes a feedforward neural network (via `neuralnet`) for one or multiple target columns.

Usage

```
WaveSNN(
  Data,
  Spatial_Matrix,
  Lag = 4,
```

```

Wfilter = "d4",
Wlevel = 4,
Split = 0.8,
hidden_grid = list(c(5), c(10), c(15), c(10, 5), c(15, 10)),
threshold_grid = c(0.01, 0.001),
stepmax_grid = c(1e+05, 2e+05),
algorithm_grid = c("rprop+"),
y_cols = NULL,
boundary = "periodic",
fast = TRUE,
seed = 123,
verbose = TRUE
)

```

Arguments

Data	A numeric matrix or data.frame. Non-numeric columns should be removed beforehand.
Spatial_Matrix	Square numeric matrix used for spatial transform (Bs). The function uses the first k columns of Data where $k = \min(\text{ncol}(\text{Data}), \text{nrow}(\text{Spatial_Matrix}), \text{ncol}(\text{Spatial_Matrix}))$.
Lag	Integer. Maximum lag used in <code>tsutils::lagmatrix()</code> .
Wfilter	Character. Wavelet filter name passed to <code>wavelets::modwt()</code> (e.g., "d4", "la8").
Wlevel	Integer. Wavelet decomposition level.
Split	Numeric in (0,1). Train ratio for time-order split.
hidden_grid	List of integer vectors. Hidden layer sizes to try, e.g. <code>list(c(5), c(10), c(10,5))</code> .
threshold_grid	Numeric vector. neuralnet convergence threshold values.
stepmax_grid	Numeric vector. neuralnet stepmax values.
algorithm_grid	Character vector. neuralnet algorithms, e.g. "rprop+".
y_cols	Integer vector. Target column indices in Data. Default = 1:k.
boundary	Character. Boundary for MODWT, default "periodic".
fast	Logical. Passed to MODWT; default TRUE.
seed	Integer. Random seed.
verbose	Logical. If TRUE, prints accuracy table.

Value

A list with:

- `hypertune_all`: all hyperparameter runs for all targets
- `best_hyper_table`: best hyperparameters per target
- `accuracy_table`: best train/test metrics per target
- `best_models`: list of fitted neuralnet objects per target
- `predictions`: list of train/test data.frames (Actual vs Predicted) per target

References

Paul, R.K., Yeasin, M. and Manjunatha, B. (2025). WaveDeepCrop: wavelet enhanced deep learning framework for noise-resilient crop yield forecasting. *Proceedings of the Indian National Science Academy*, 91(4), 1310–1323.

Examples

```
Data <- matrix(rnorm(300), ncol = 3)
Bs <- matrix(c(0,1,0,
              0.5,0,0.5,
              0,1,0), nrow = 3, byrow = TRUE)

res <- WaveSNN(
  Data = Data,
  Spatial_Matrix = Bs,
  Lag = 4,
  Wfilter = "d4",
  Wlevel = 4,
  Split = 0.8,
  hidden_grid = list(c(5)),          # minimal to keep example fast
  threshold_grid = c(0.01),
  stepmax_grid = c(1e5),
  algorithm_grid = c("rprop+"),
  verbose = FALSE
)
res$accuracy_table
```

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