Package 'SemiparMF'

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Title Semiparametric Spatiotemporal Model with Mixed Frequencies

Version 1.0.0

Description Fits a semiparametric spatiotemporal model for data with mixed frequencies, specifically where the response variable is observed at a lower frequency than some covariates. The estimation uses an iterative backfitting algorithm that combines a non-parametric smoothing spline for high-frequency data, parametric estimation for low-frequency and spatial neighborhood effects, and an autoregressive error structure. Methodology based on Malabanan, Lansangan, and Barrios (2022) <https://scienggj.org/2022/SciEnggJ%202022-vol15-no02-p90-107-Malabanan%20et%20al.pdf>.

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Encoding UTF-8

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Imports graphics, sf, spdep, stats, utils

Suggests testthat (>= 3.0.0)

Config/testthat/edition 3

URL https://github.com/jzeuzs/SemiparMF, https://semiparmf.j3z.dev

BugReports https://github.com/jzeuzs/SemiparMF/issues

NeedsCompilation no

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Contents

`plot.semiparMF` *Plot Convergence History*

Description

Plots the Mean Squared Prediction Error (MSPE) across iterations.

Usage

```
## S3 method for class 'semiparMF'
plot(x, ...)
```

Arguments

`x`	An object of class `semiparMF`.
`...`	Additional graphical parameters.

Value

No return value, called for side effects (plotting).

`predict.semiparMF` *Predict Method for SemiparMF*

Description

Generates predictions for new data. Reference: "Predicted values are calculated by simply adding up the scores... and the linear combination".

Usage

```
## S3 method for class 'semiparMF'
predict(object, new_high_freq, new_z, new_w, ...)
```

Arguments

object	An object of class semiparMF.
new_high_freq	Numeric array (N x T_new x K) for the high-frequency covariate.
new_z	Numeric matrix (N x T_new) for the parametric covariate.
new_w	Numeric matrix (N x T_new) for the neighborhood covariate.
...	Additional arguments.

Value

A matrix (N x T_new) of predicted values.

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print.semiparMF *Print Method for SemiparMF*

Description

Print Method for SemiparMF

Usage

```
## S3 method for class 'semiparMF'
print(x, ...)
```

Arguments

x	An object of class semiparMF.
...	Additional arguments.

Value

The input object x is returned invisibly.

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print.summary.semiparMF *Print Summary for SemiparMF*

Description

Print Summary for SemiparMF

Usage

```
## S3 method for class 'summary.semiparMF'
print(x, ...)
```

Arguments

x	An object of class summary.semiparMF.
...	Additional arguments.

Value

The input object x is returned invisibly.

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semiparMF *Fit Semiparametric Spatiotemporal Model with Mixed Frequencies*

Description

Fits a spatiotemporal model where the response variable is observed at a lower frequency (e.g., quarterly) than a non-parametric covariate (e.g., monthly). The model combines a non-parametric component for the high-frequency predictor, parametric components for low-frequency predictors and spatial neighborhood effects, and an autoregressive error structure.

Usage

```
semiparMF(
  formula,
  data_sf,
  high_freq_data,
  time_col,
  id_col,
  w_matrix = NULL,
  ...
)
```

Arguments

formula	A formula object (e.g., Y ~ Z). The left-hand side is the response variable (low frequency). The first predictor on the right-hand side is the parametric covariate (Z) measured at the same frequency.
data_sf	An sf object containing the panel data in long format. Must contain columns for the response, the parametric covariate, the time index, and the location ID.
high_freq_data	A numeric array of dimensions (N x T x K), where: • N: Number of unique spatial locations (must match data_sf). • T: Number of time points (must match data_sf). • K: The frequency ratio (e.g., 3 if predictor is monthly and response is quarterly).
time_col	Character string. The name of the column in data_sf representing the time index.

id_col	Character string. The name of the column in data_sf representing the location ID.
w_matrix	Optional numeric matrix (N x T). A pre-calculated spatial weight or neighborhood variable. If NULL (default), a spatial lag of the variable Z is calculated using Queen Contiguity weights.
...	Additional arguments passed to the internal backfitting function (e.g., max_iter, tol, spar).

Value

An object of class semiparMF containing:

coefficients	A list of estimated parameters: beta (parametric covariate effect), gamma (neighborhood effect), and rho (autoregressive parameter).
nonparam	A list containing the fitted smoothing spline and the aggregated non-parametric component f_hat.
residuals	Matrix (N x T) of model residuals.
fitted.values	Matrix (N x T) of the fitted values (structural part only).
dims	Dimensions of the data (N, T).
meta	Metadata containing location IDs and time indices.
history	Convergence history (MSPE per iteration).
call	The function call.

References

Malabanan, V. A., Lansangan, J. R. G., & Barrios, E. B. (2022). Semiparametric Spatiotemporal Model with Mixed Frequencies: With Application in Crop Forecasting. *Science & Engineering Journal*, 15(2), 90-107.

Examples

```
# Simulate data using the package's included simulation function
sim <- simulate_semipar_data(n_side = 4, t_len = 20, k = 3, rho_error = 0.5)

# Fit the model
fit <- semiparMF(
  formula = Y ~ Z,
  data_sf = sim$data,
  high_freq_data = sim$X_high,
  time_col = "time_id",
  id_col = "location_id"
)

# Inspect results
summary(fit)
```

`simulate_semipar_data` *Simulate Spatiotemporal Mixed Frequency Data*

Description

Generates a synthetic dataset for testing the SemiparMF model. Structure follows Equation (7) in Malabanan et al. (2022).

Usage

```
simulate_semipar_data(
  n_side = 6,
  t_len = 50,
  k = 3,
  rho_error = 0.5,
  beta = 0.5,
  gamma = 0.3
)
```

Arguments

`n_side`	Integer. Grid side length. Total locations N = n_side^2.
`t_len`	Integer. Length of the time series (T).
`k`	Integer. Frequency ratio (e.g., 3 months per quarter).
`rho_error`	Numeric. Autocorrelation coefficient for the error term (default 0.5).
`beta`	True coefficient for covariate Z (default 0.5).
`gamma`	True coefficient for neighborhood variable W (default 0.3).

Value

A list containing:

`data`	An `sf` object containing Y, Z, W, and geometry.
`X_high`	An array (N x T x K) of high-frequency covariates.
`true_params`	List of true parameters used for generation.

Examples

```
# Generate a small dataset
sim <- simulate_semipar_data(n_side = 4, t_len = 10, k = 3)

# Check dimensions
dim(sim$data) # 160 x 5 (16 locations * 10 time points)
dim(sim$X_high) # 16 x 10 x 3
```

summary.semiparMF *Summary Method for SemiparMF*

Description

Summary Method for SemiparMF

Usage

```
## S3 method for class 'semiparMF'
summary(object, ...)
```

Arguments

object	An object of class semiparMF.
...	Additional arguments.

Value

A list of class summary.semiparMF containing:

coefficients	A list of estimated parameters (beta, gamma, rho).
last_mspe	The Mean Squared Prediction Error from the final iteration.
residuals_summary	Summary statistics of the residuals.
iterations	Total number of iterations performed.
call	The function call.

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