Package 'LTAR'

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Type Package

Title Tensor Forecasting Functions

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Description A set of tools for forecasting the next step in a multidimensional setting using tensors. In the examples, a forecast is made of sea surface temperatures of a geographic grid (i.e. lat/long). Each observation is a matrix, the entries in the matrix and the sea surface temperature at a particular lattitude/longitude. Cates, J., Hoover, R. C., Caudle, K., Kopp, R., & Ozdemir, C. (2021) ``Transform-Based Tensor Auto Regression for Multilinear Time Series Forecasting" in 2021 20th IEEE International Conference on Machine Learning and Applications (ICMLA) (pp. 461-466), IEEE <doi:10.1109/ICMLA52953.2021.00078>.

Depends R (>= 4.2.0)

Imports vars,stats,rTensor, rTensor2, gsignal

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`err` *Forecast error calculations*

Description

Determines the Frobenius norm between true tensor and the actual tensor.

Usage

```
err(true_tensor, forecast_tensor)
```

Arguments

`true_tensor`	: The true tensor from the test set.
`forecast_tensor`	: The predicted values from LTARpred()

Value

Error: The Frobenius norm between the actual and predictor tensor slices at each forecast step.

Author(s)

Kyle Caudle

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Examples

```
require(rTensor)
data(tensor)
tnsr <- as.tensor(tensor)
tensorTest <- tnsr[,1:2,]
tensorTrain <- tnsr[,3:2000,]
forecast <- LTARpred(p=5,tensorTrain,h=2)
predTensor <- forecast$ypred
errors <- err(tensorTest,predTensor)
errors
```

LTAR *Tensor Autoregression (TAR) Model*

Description

Fits a Tensor Autoregression (TAR) Model to historical 3D tensor data and returns the coefficient tensor (A) and the constant matrix (C).

$$\mathbf{A} = [A_1|A_2|\ldots|A_p], \mathbf{C}$$

Usage

```
LTAR(p,tnsr,type = c("const", "trend", "both", "none"),season=NULL)
```

Arguments

p	: Number of lags
tnsr	: A 3D tensor
type	:Type of deterministic regressors to include.
season	: Inclusion of centered seasonal dummy variables (integer value of frequency).

Value

The coefficient tensor

$$\mathbf{A} = [A_1|A_2|\ldots|A_p]$$

and the constant matrix

$$C$$

for the LTAR model:

$$\mathbf{y}_t = A_1\mathbf{y}_{t-1} + \ldots + A_p\mathbf{y}_p + CD_t + \mathbf{u}_t.$$

Author(s)

Kyle Caudle

Randy Hoover

Jackson Cates

References

Cates, J., Hoover, R. C., Caudle, K., Kopp, R., & Ozdemir, C. (2021, December). Transform-Based Tensor Auto Regression for Multilinear Time Series Forecasting. In 2021 20th IEEE International Conference on Machine Learning and Applications (ICMLA) (pp. 461-466). IEEE.

Examples

```
require(rTensor)
data(tensor)
tnsr <- as.tensor(tensor)
# an LTAR(1) model with trend
model <- LTAR(p=1,tnsr,type="trend")
```

LTARpred *Forecast for a 3D Tensor Autoregression Model*

Description

Using a historical 3D tensor, the LTARpred function will forecast h steps into the future.

Usage

```
LTARpred(p, tnsr, h, type = c("const", "trend", "both", "none"), season = NULL)
```

Arguments

p	: Number of time series lags
tnsr	: A 3D tensor
h	: Number of steps to forecast
type	Type of deterministic regressors to include.
season	: Inclusion of centered seasonal dummy variables (integer value of frequency).

Value

A Tensor-class object which contains the h step forecasts.

Author(s)

Kyle Caudle

Randy Hoover

Jackson Cates

References

Cates, J., Hoover, R. C., Caudle, K., Kopp, R., & Ozdemir, C. (2021, December). Transform-Based Tensor Auto Regression for Multilinear Time Series Forecasting. In 2021 20th IEEE International Conference on Machine Learning and Applications (ICMLA) (pp. 461-466). IEEE.

Examples

```
require(rTensor)
data(tensor)
tnsr <- as.tensor(tensor)
result <- LTARpred(p=5,tnsr,h=2,type="trend",season=12)
```

Ltrans *Tensor Transformation*

Description

Performs a tensor transformation of a 3D tensor using the discrete cosine transform along mode 3.

Usage

```
Ltrans(tnsr)
```

Arguments

tnsr	: A 3D tensor

Value

a Tensor-class object that has been transformed using the DCT.

Author(s)

Kyle Caudle

Randy Hoover

Jackson Cates

Examples

```
require(rTensor)
data(tensor)
tnsr <- as.tensor(tensor)
trans_tensor <- Ltrans(tnsr)
# print first lateral slice
trans_tensor[,1,]
```

tensor *Sea Surface Temperatures*

Description

A 5-by-6 grid of sea-surface temperatures from 5 degrees N, 180 degrees W to 5 degrees S, 110 degrees W recorded hourly from 7:00PM on 4/26/94 to 3:00AM on 7/19/94, yielding 2000 epochs.

Usage

```
data("tensor")
```

Format

The format is: num [1:5, 1:2000, 1:6] 28.1 28.4 28.1 28.6 29.3 ...

References

Mark Rogers, Lei Li, and Stuart J Russell, "Multilinear dynamical systems for tensor time series," in Advances in Neural Information Processing Systems (NIPS), 2013, pp. 2634–2642.

Examples

```
data(tensor)
```

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