Package ‘MultiwayRegression’

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Type Package
Title Perform Tensor-on-Tensor Regression
Version 1.2
Date 2019-05-28
Author Eric F. Lock
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Description Functions to predict one multi-way array (i.e., a tensor) from another multi-way array, using a low-rank CANDECOMP/PARAFAC (CP) factorization and a ridge (L_2) penalty [Lock, EF (2018) <doi:10.1080/10618600.2017.1401544>]. Also includes functions to sample from the Bayesian posterior of a tensor-on-tensor model.
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MultiwayRegression-package

Perform tensor-on-tensor regression

Description

Functions to predict one multi-way array (i.e., a tensor) from another multi-way array, using a low-rank CANDECOMP/PARAFAC (CP) factorization and a ridge (L_2) penalty. Also includes functions to sample from the Bayesian posterior of a tensor-on-tensor model.

Details

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Author(s)

Eric F. Lock
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References


Examples

data(SimData) # loads simulated X: 100 x 15 x 20 and Y: 100 x 5 x 10
Results <- rrr(X,Y,R=2) # Fit rank 2 model with no regularization
Y_pred <- ctprod(X,Results$B,2) # Array of fitted values

ctprod

Compute the contracted tensor product between two multiway arrays.

Description

Computes the contracted tensor product between two multiway arrays.
Usage

\texttt{cprod(A,B,K)}

Arguments

A An array of dimension $P_1 \times \ldots \times P_L \times R_1 \times \ldots \times R_K$.

B An array of dimension $R_1 \times \ldots \times R_K \times Q_1 \times \ldots \times Q_M$.

K A positive integer, giving the number of modes to collapse.

Value

An array $C$ of dimension $P_1 \times \ldots \times P_L \times Q_1 \times \ldots \times Q_M$, given by the contracted tensor product of $A$ and $B$.

Author(s)

Eric F. Lock

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\textit{rrr} Penalized reduced rank regression for tensors

Description

Fits a linear model to estimate one multi-way array from another, under the restriction that the coefficient array has given PARAFAC rank. By default, estimates are chosen to minimize a least-squares objective; an optional penalty term allows for $L_2$ regularization of the coefficient array.

Usage

\texttt{rrr(X,Y,R=1,lambda=0,annealIter=0,convThresh=10^(-5), seed=0)}

Arguments

X A predictor array of dimension $N \times P_1 \times \ldots \times P_L$.

Y An outcome array of dimension $N \times Q_1 \times \ldots \times Q_M$.

R Assumed rank of the $P_1 \times \ldots \times P_L \times Q_1 \times \ldots \times Q_M$ coefficient array.

lambda Ridge ($L_2$) penalty parameter for the coefficient array.

annealIter Number of tempering iterations to improve initialization

convThresh Converge threshold for the absolute difference in the objective function between two iterations

seed Random seed for generation of initial values.
Value

U List of length L. U[[l]]: P_l x R gives the coefficient basis for the l’th mode of X.
V List of length M. V[[m]]: Q_m x R gives the coefficient basis for the m’th mode of Y.
B Coefficient array of dimension P_1 x ... x P_L x Q_1 x ... x Q_M. Given by the CP factorization defined by U and V.
sse Vector giving the sum of squared residuals at each iteration.
sseR Vector giving the value of the objective (sse+penalty) at each iteration.

Author(s)

Eric F. Lock

References


Examples

data(SimData) ##loads simulated X: 100 x 15 x 20 and Y: 100 x 5 x 10
Results <- rrr(X,Y,R=2) ##Fit rank 2 model with no regularization
Y_pred <- ctprod(X,Results$B,2) ##Array of fitted values

rrrBayes

Bayesian inference for reduced rank regression

Description

Performs Bayesian inference for a linear model to estimate one multi-way array from another, under the restriction that the coefficient array has given PARAFAC rank.

Usage

rrrBayes(X,Y,Inits,X.new,R=1,lambda=0,Samples=1000, thin=1,seed=0)

Arguments

X A predictor array of dimension N x P_1 x ... x P_L for the training data.
Y An outcome array of dimension N x Q_1 x ... x Q_M for the training data.
Inits Initial values. Inits$U gives a list of length L where Inits$U[[l]]: P_l x R gives the coefficient basis for the l’th mode of X. Inits$V gives a list of length M where Inits$V[[m]]: Q_m x R gives the coefficient basis for the m’th mode of Y. Can be the output of rrr(...).
SimData

**X, new**  
Predictor array of dimension $M \times P_1 \times \ldots \times P_L$. Each row gives the entries for a new $P_1 \times \ldots \times P_L$ predictor observation in vectorized form.

**R**  
Assumed rank of the $P_1 \times \ldots \times P_L \times Q_1 \times \ldots \times Q_M$ coefficient array.

**lambda**  
Ridge ($L_2$) penalty parameter for the coefficient array, inversely proportional to the variance of the coefficients under a Gaussian prior.

**Samples**  
Length of the MCMC sampling chain.

**thin**  
Thinning value, for thin=j, only every j’th observation in the MCMC chain is saved.

**seed**  
Random seed for generation of initial values.

**Value**

An array of dimension $(\text{Samples}/\text{thin}) \times M \times Q_1 \times \ldots \times Q_M$, giving $(\text{Samples}/\text{thin})$ samples from the posterior predictive of the outcome array predicted by Xmat.new.

**Author(s)**

Eric F. Lock

**References**


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SimData  
*Simulated multi-way data for prediction*

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**Description**

Simulated multi-way data for prediction.

**Format**

- X: predictor array of dimension 100 x 15 x 20
- Y: outcome array of dimension 100 x 5 x 10

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X  
*Simulated multi-way data for prediction*

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Simulated multi-way data for prediction.

**Format**

- X: predictor array of dimension 100 x 15 x 20
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Simulated multi-way data for prediction

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