Package 'GrFA'

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Type Package

Title Group Factor Analysis

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Description Several group factor analysis algorithms are implemented, including Canonical Correlation-based Estimation by Choi et al. (2021) <doi:10.1016/j.jeconom.2021.09.008> , Generalised Canonical Correlation Estimation by Lin and Shin (2022) <doi:10.2139/ssrn.4295429>, Circularly Projected Estimation by Chen (2022) <doi:10.1080/07350015.2022.2051520>, and the approach we recently proposed, named Aggregated Projection Method.

Imports mvtnorm

Depends R (>= 3.5.0)

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R topics documented:

APM *Weighted Projection Estimation*

Description

Weighted Projection Estimation

Usage

```
APM(y, rmax = 8, r0 = NULL, r = NULL, weight = TRUE, method = "ic1", type = "BIC3")
```

Arguments

y	a list of the observation data, each element is a data matrix of each group with dimension $T * N_m$.
rmax	the maximum factor numbers of all groups.
r0	the number of global factors, default is NULL, the algorithm will automatically estimate the number of global factors. If you have the prior information about the true number of global factors, you can set it by your own.
r	the number of local factors in each group, default is NULL, the algorithm will automatically estimate the number of local factors. If you have the prior information about the true number of local factors, you can set it by your own, notice it should be an integer vector of length M (the number of groups).
weight	the weight of each projection matrix, default is TRUE, means $w_m = N_m/N$, if weight = FALSE, then simply calculate the mean of all projection matrices.
method	the method used in the algorithm, default is ic1, it can also be ic2 and gap.
type	the method used in estimating the factor numbers in each group initially, default is BIC3, it can also be IC3

Value

r0hat	the estimated number of the global factors.
rho	the estimated number of the local factors.
Ghat	the estimated global factors.
Fhat	the estimated local factors.
loading_G	a list consisting of the estimated global factor loadings.
loading_F	a list consisting of the estimated local factor loadings.
e	a list consisting of the residuals.
threshold	the threshold used in determining the number of global factors, only for method = ic1 and method = ic2.

Author(s)

Jiaqi Hu

Examples

```
dat = gendata()
dat
APM(dat$y, method = "ic1")
APM(dat$y, method = "ic2")
APM(dat$y, method = "gap")
```

CCA *Canonical Correlation Estimation*

Description

Canonical Correlation Estimation

Usage

```
CCA(y, rmax = 8, r0 = NULL, r = NULL, method = "CCD", type = "BIC3")
```

Arguments

y	a list of the observation data, each element is a data matrix of each group with dimension $T * N_m$.
rmax	the maximum factor numbers of all groups.
r0	the number of global factors, default is NULL, the algorithm will automatically estimate the number of global factors. If you have the prior information about the true number of global factors, you can set it by your own.
r	the number of local factors in each group, default is NULL, the algorithm will automatically estimate the number of local factors. If you have the prior information about the true number of local factors, you can set it by your own, notice it should be an integer vector of length M (the number of groups).
method	the method used in the algorithm, default is CCD, it can also be MCC.
type	the method used in estimating the factor numbers in each group initially, default is BIC3, it can also be IC3

Value

r0hat	the estimated number of the global factors.
rho	the estimated number of the local factors.
Ghat	the estimated global factors.
Fhat	the estimated local factors.
loading_G	a list consisting of the estimated global factor loadings.

loading_F	a list consisting of the estimated local factor loadings.
e	a list consisting of the residuals.
threshold	the threshold used in determining the number of global factors, only for method = "MCC".

References

Choi, I., Kim, D., Kim, Y. J., & Kwark, N. S. (2018). A multilevel factor model: Identification, asymptotic theory and applications. Journal of Applied Econometrics, 33(3), 355-377.

Choi, I., Lin, R., & Shin, Y. (2021). Canonical correlation-based model selection for the multilevel factors. Journal of Econometrics.

Examples

```
dat = gendata()
dat
CCA(dat$y, method = "CCD")
CCA(dat$y, method = "MCC")
```

CP *Circularly Projected Estimation*

Description

Circularly Projected Estimation

Usage

```
CP(y, rmax = 8, r0 = NULL, r = NULL, type = "BIC3")
```

Arguments

y	a list of the observation data, each element is a data matrix of each group with dimension $T * N_m$.
rmax	the maximum factor numbers of all groups.
r0	the number of global factors, default is NULL, the algorithm will automatically estimate the number of global factors. If you have the prior information about the true number of global factors, you can set it by your own.
r	the number of local factors in each group, default is NULL, the algorithm will automatically estimate the number of local factors. If you have the prior information about the true number of local factors, you can set it by your own, notice it should be an integer vector of length M (the number of groups).
type	the method used in estimating the local factor numbers in each group after projecting out the global factors, default is BIC3, it can also be IC3....

Value

r0hat	the estimated number of the global factors.
rho	the estimated number of the local factors.
Ghat	the estimated global factors.
Fhat	the estimated local factors.
loading_G	a list consisting of the estimated global factor loadings.
loading_F	a list consisting of the estimated local factor loadings.
e	a list consisting of the residuals.

References

Chen, M. (2023). Circularly Projected Common Factors for Grouped Data. Journal of Business & Economic Statistics, 41(2), 636-649.

Examples

```
dat = gendata()
dat
CP(dat$y)
```

---

est_num *Estimate factor numbers*

Description

Estimate factor numbers.

Usage

```
est_num(X, kmax = 8, type = "BIC3")
```

Arguments

X	the observation data matrix of dimension $T \times N$.
kmax	the maximum number of factors.
type	the criterion used in determining the number of factors, default is type = "BIC3", it can also be "PC1", "PC2", "PC3", "IC1", "IC2","IC3", "AIC3", "BIC3", "ER", "GR".

Value

rhat	the estimated number of factors.

References

Bai, J., & Ng, S. (2002). Determining the number of factors in approximate factor models. Econometrica, 70(1), 191-221.

Ahn, S. C., & Horenstein, A. R. (2013). Eigenvalue ratio test for the number of factors. Econometrica, 81(3), 1203-1227.

FA *Classical factor analysis*

Description

Classical factor analysis.

Usage

```
FA(X, r)
```

Arguments

X	the observation data matrix of dimension $T \times N$.
r	the factor numbers need to estimated.

Value

F	the estimated factors.
L	the estimated factor loadings.

Author(s)

Jiaqi Hu

References

Bai, J., & Ng, S. (2002). Determining the number of factors in approximate factor models. Econometrica, 70(1), 191-221.

GCC *Generalised Canonical Correlation*

Description

Generalised Canonical Correlation

Usage

```
GCC(y, rmax = 8, r0 = NULL, r = NULL, type = "BIC3")
```

Arguments

y	a list of the observation data, each element is a data matrix of each group with dimension $T * N_m$.
rmax	the maximum factor numbers of all groups.
r0	the number of global factors, default is NULL, the algorithm will automatically estimate the number of global factors. If you have the prior information about the true number of global factors, you can set it by your own.
r	the number of local factors in each group, default is NULL, the algorithm will automatically estimate the number of local factors. If you have the prior information about the true number of local factors, you can set it by your own, notice it should be an integer vector of length M (the number of groups).
type	the method used in estimating the factor numbers in each group initially, default is BIC3, it can also be IC3

Value

r0hat	the estimated number of the global factors.
rho	the estimated number of the local factors.
Ghat	the estimated global factors.
Fhat	the estimated local factors.
loading_G	a list consisting of the estimated global factor loadings.
loading_F	a list consisting of the estimated local factor loadings.
e	a list consisting of the residuals.

References

Lin, R., & Shin, Y. (2022). Generalised Canonical Correlation Estimation of the Multilevel Factor Model. Available at SSRN 4295429.

Examples

```
dat = gendata()
dat
GCC(dat$y)
```

gendata *Generate the grouped data.*

Description

Generate the grouped data.

Usage

```
gendata(seed = 1, T = 50, N = rep(30, 5), r0 = 2, r = rep(2, 5),
        Phi_G = 0.5, Phi_F = 0.5, Phi_e = 0.5, W_F = 0.5, beta = 0.1,
        kappa = 1, case = 1)
```

Arguments

seed	the seed used in set.seed.
T	the number of time points.
N	a vector representing the number of variables in each group.
r0	the number of global factors.
r	a vector representing the number of the local factors. Notice, the length of r is the same as N.
Phi_G	hyperparameter of the global factors, default is 0.5, the value should between 0 and 1.
Phi_F	hyperparameter of the local factors, default is 0.5, the value should between 0 and 1.
Phi_e	hyperparameter of the errors, default is 0.5, the value should between 0 and 1.
W_F	hyperparameter of the correlation of local factors, only applicable in case = 3, the value should between 0 and 1.
beta	hyperparameter of the errors, default is 0.1.
kappa	hyperparameter of signal to noise ratio, default is 1.
case	the case of the data-generating process, default is 1, it can also be 2 and 3.

Value

y	a list of the data.
G	the global factors.
F	a list of the local factors.
loading_G	the global factor loadings.
loading_F	the local factor loadings.
T	the number of time points.
N	a vector representing the number of variables in each group.
M	the number of groups.

r0	the number of global factors.
r	a vector representing the number of the local factors.
case	the case of the data-generating process.

Examples

```
dat = gendata()
dat
```

---

print.GFA *Print*

Description

Print the summarized results of the estimated group factor model, such as the estimated global and local factors.

Usage

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

Arguments

x	the GFA object returned from the algorithm.
...	additional print arguments.

Value

No return value, called for side effects

TraceRatio *Trace ratios*

Description

Evaluation of the estimated factors by trace ratios, the values is between 0 and 1, higher values means better estimation.

Usage

```
TraceRatio(G, Ghat)
```

Arguments

G	the true factors.
Ghat	the estimated factors.

Value

`ratios` the trace ratios: TR1, TR2.

Author(s)

Jiaqi Hu

`UShouseprice` *Housing price data for 16 states in the U.S.*

Description

Housing price data for 16 states in the U.S over the period Jan 2000 to April 2023.

Usage

```
data("UShouseprice")
```

Format

A list with a length of 16. Each element is a matrix of dimension $T * N_m$.

Source

The original data is downloaded from the website of Zillow.

Examples

```
data(UShouseprice)
log_diff = function(x){
  T = nrow(x)
  res = log(x[2:T,]/x[1:(T-1),])*100
  scale(res, center = TRUE, scale = TRUE)
}
UShouseprice1 = lapply(UShouseprice, log_diff)
```

Index