

Package ‘ReguGLH’

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Type Package

Title General Linear Hypothesis Tests via Spectral Shrinkage

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Description Implements high-dimensional general linear hypothesis tests using ridge, reciprocal cubic polynomial, and user-defined analytic spectral regularizers. Provides prior-based shrinkage selection and Gaussian maximum calibration for composite tests. Implements the methods of Li, Aue and Paul (2020), ``High-dimensional general linear hypothesis tests via non-linear spectral shrinkage", Bernoulli, 26(4), 2541-2571 <doi:10.3150/19-BEJ1186>.

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 ReguGLH-package

General Linear Hypothesis Tests via Spectral Shrinkage

Description

Implements the methods of Li, Aue and Paul (2020), including ridge, reciprocal cubic polynomial, and general analytic regularization.

Details

P-values use asymptotic approximations. A small Gaussian MANOVA study found mild finite-sample LH size inflation; see the package README and installed VALIDATION.md for the design and results. General analytic functions require an admissible contour and numerical convergence checks.

References

Li, H., Aue, A. and Paul, D. (2020). High-dimensional general linear hypothesis tests via non-linear spectral shrinkage. *Bernoulli*, 26(4), 2541–2571. doi:[10.3150/19BEJ1186](https://doi.org/10.3150/19BEJ1186).

See Also

[glh_test](#), [shrinkage_moments](#), [cubic_grid](#)

 cubic_grid

Generate a cubic coefficient search grid

Description

Generate a cubic coefficient search grid

Usage

```
cubic_grid(eigenvalues, resolution = 5L)
```

Arguments

eigenvalues	Residual covariance eigenvalues, including zeros.
resolution	Number of grid points per dimension (at least two).

Value

Matrix with columns l0,l1,l2,l3 satisfying the supplementary material's monotonicity and discriminant restrictions.

References

Li, H., Aue, A. and Paul, D. (2020). High-dimensional general linear hypothesis tests via non-linear spectral shrinkage. *Bernoulli*, 26(4), 2541–2571. doi:10.3150/19BEJ1186.

glh_test

Spectral shrinkage general linear hypothesis test

Description

Tests $BC = 0$ in $Y = BX + \text{error}$. Columns of Y are observations. Selection maximizes the estimated local power numerator divided by the square root of the estimated variance on a finite candidate grid.

Usage

```
glh_test(Y, X, C, family = c("linear", "cubic", "general"),
  mode = c("single", "composite"), prior = c(1, 0, 0),
  priors = diag(3), parameters = NULL, regularizer = NULL,
  contour = NULL, nquad = 256L, nsim = 10000L, alpha = 0.05)
```

Arguments

Y	Numeric p by N response matrix.
X	Numeric k by N full row rank design matrix.
C	Numeric k by q full column rank contrast matrix.
family	One of linear (ridge), cubic (reciprocal polynomial), general.
mode	Single prior test or maximum across multiple priors.
prior	Nonnegative length-three weights for a single test.
priors	Matrix of nonnegative prior rows for a composite test.
parameters	Candidate parameters; see shrinkage_moments. Defaults to 60 logarithmically spaced negative ridge parameters or cubic_grid.
regularizer	Vectorized function(z, parameter) for general shrinkage.
contour	Circular integration contour; see shrinkage_moments.
nquad	Contour quadrature node count.
nsim	Number of Gaussian simulations for composite calibration.
alpha	Significance level.

Details

Calibration is asymptotic. A small Gaussian MANOVA study found mild finite-sample LH size inflation (up to 7.6 percent at nominal 5 percent). See the package README and installed VALIDATION.md.

Value

A list with statistic, p.value and reject for LR, LH and BNP; component statistics, selected parameters, prior weights, moments, covariance before and after PSD projection, and residual dimensions.

References

Li, H., Aue, A. and Paul, D. (2020). High-dimensional general linear hypothesis tests via non-linear spectral shrinkage. *Bernoulli*, 26(4), 2541–2571. doi:[10.3150/19BEJ1186](https://doi.org/10.3150/19BEJ1186).

Examples

```
set.seed(1)
Y <- matrix(rnorm(10 * 40), 10, 40)
X <- rbind(1, rep(c(0, 1), each = 20))
C <- matrix(c(0, 1), 2, 1)
glh_test(Y, X, C)
glh_test(Y, X, C, mode = "composite", nsim = 1000)
```

shrinkage_moments	<i>Estimate null moments and prior power numerators</i>
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Description

Estimate null moments and prior power numerators

Usage

```
shrinkage_moments(eigenvalues, gamma,
  family = c("linear", "cubic", "general"), parameters,
  regularizer = NULL, contour = NULL, nquad = 256L)
```

Arguments

eigenvalues	Nonnegative eigenvalues of the residual covariance, including its zero eigenvalues.
gamma	Dimension divided by residual degrees of freedom.
family	One of linear, cubic, general.
parameters	Negative ridge parameters; cubic coefficient matrix with columns l0,l1,l2,l3; or matrix of user-defined parameter rows.
regularizer	Vectorized function(z, parameter) supporting complex z.
contour	List with center and radius for a counterclockwise circle. Must enclose the empirical spectrum and kernel singularities, but no singularities of the regularizers. Required for the general family.
nquad	Number of equally spaced midpoint contour nodes.

Value

List containing omega, delta, numerator (three prior basis columns), parameters, and complex numerical estimates for the general family.

References

Li, H., Aue, A. and Paul, D. (2020). High-dimensional general linear hypothesis tests via non-linear spectral shrinkage. *Bernoulli*, 26(4), 2541–2571. doi:[10.3150/19BEJ1186](https://doi.org/10.3150/19BEJ1186).

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