Package: elitism (via r-universe)

August 26, 2024

Type Package

Title Equipment for Logarithmic and Linear Time Stepwise Multiple Hypothesis Testing

Version 1.1.1

Date 2023-08-17

Description Recently many new p-value based multiple test procedures have been proposed, and these new methods are more powerful than the widely used Hochberg procedure. These procedures strongly control the familywise error rate (FWER). This is a comprehensive collection of p-value based FWER-control stepwise multiple test procedures, including six procedure families and thirty multiple test procedures. In this collection, the conservative Hochberg procedure, linear time Hommel procedures, asymptotic Rom procedure, Gou-Tamhane-Xi-Rom procedures, and Quick procedures are all developed in recent five years since 2014. The package name ``elitism" is an acronym of ``e"quipment for ``l"ogarithmic and l``i"near ``ti"me ``s"tepwise ``m"ultiple hypothesis testing. See Gou, J. (2022), ``Quick multiple test procedures and p-value adjustments", Statistics in Biopharmaceutical Research 14(4), 636-650.

License GPL-3

Encoding UTF-8

Depends R (>= 4.2.0)

Imports MASS (>= 7.0.0), stats (>= 4.0.0)

RoxygenNote 7.2.3

NeedsCompilation no

Author Jiangtao Gou [aut, cre], Fengqing (Zoe) Zhang [aut]

Maintainer Jiangtao Gou <gouRpackage@gmail.com>

Repository CRAN

Date/Publication 2023-09-02 22:20:05 UTC

Contents

`mtp` *Multiple Test Procedures*

Description

Given a set of p-values and the level of significance, returns decisions whether the corresponding hypotheses should be rejected or not, including the hybrid Hochberg-Hommel procedure (Gou et al., 2014) and Quick procedure (Gou and Zhang, 2022).

Usage

```
mtp(p, alpha = 0.05, method = "gtxr", n = length(p))
```

Arguments

`p`	vector of p-values.
`alpha`	the level of significance.
`method`	multiplicity correction method, including the Holm procedure ("holm"), the Hochberg procedure ("hochberg", "chochberg"), the Hommel procedure ("hommel", "hommelq", "hommell", "hommellsi", "hommellsb"), the Rom procedure ("rom", "rom1", "roma", "romx"), the Gou-Tamhane-Xi-Rom procedure ("gtxr", "gtxr0i", "gtxr1ci", "gtxr2di", "gtxr0b", "gtxr1cb", "gtxr2db"), and the Quick procedure ("quick", "quick00i", "quick01i", "quick10i", "quick11i", "quickxi", "quick00b", "quick01b", "quick10b", "quick11b", "quickxb").
`n`	number of p-values.

Details

Given a set of p-values, returns a binary vector of decisions, where 1 stands for rejection, and 0 stands for acceptance. There are six families of procedures.

1. Holm procedure (1 procedure)
   (a) *holm*, the Holm (1979) step-down method.
2. Hochberg procedure (2 procedures)
   (a) *hochberg*, the Hochberg (1988) step-up method.
   (b) *chochberg*, the conservative Hochberg method developed by Gou and Tamhane (2018).
3. Hommel procedure (5 procedures)

(a) *hommel*, the Hommel (1988) step-up method, linear time algorithm with standard binary search, equivalent to *hommellsb*.

(b) *hommelq*, the Hommel (1988) step-up method, quadratic time algorithm.

(c) *hommell*, the Hommel (1988) step-up method, linear time algorithm by Meijer, Krebs and Goeman (2019).

(d) *hommellsb*, the Hommel (1988) step-up method, linear time algorithm by Meijer, Krebs and Goeman (2019), with standard binary search enhancement.

(e) *hommellsi*, the Hommel (1988) step-up method, linear time algorithm by Meijer, Krebs and Goeman (2019), with interpolation search enhancement.

4. Rom procedure (4 procedure)

(a) *rom*, the Rom (1990) step-up method, equivalent to *romx*.

(b) *rom1*, the Rom-1 method proposed by Gou and Zhang (2020).

(c) *roma*, the Rom-1A method proposed by Gou and Zhang (2020).

(d) *romx*, the Rom (1990) step-up method.

5. Gou-Tamhane-Xi-Rom procedure (7 procedure)

(a) *gtxr*, the zeroth order hybrid Hommel-Hochberg procedure, proposed by Gou et al. (2014), equivalent to *gtxr0b*.

(b) *gtxr0b*, the zeroth order GTXR procedure, with standard binary search enhancement.

(c) *gtxr1cb*, the GTXR procedure with refined c critical constants, with standard binary search enhancement.

(d) *gtxr2db*, the GTXR procedure with refined d critical constants, with standard binary search enhancement.

(e) *gtxr0i*, the zeroth order GTXR procedure, with interpolation search enhancement.

(f) *gtxr1ci*, the GTXR procedure with refined c critical constants, with interpolation search enhancement.

(g) *gtxr2di*, the GTXR procedure with refined d critical constants, with interpolation search enhancement.

6. Quick procedure (11 procedure)

(a) *quick*, the Quick method, proposed by Gou and Zhang (2020), equivalent to *quick00b*.

(b) *quick00b*, the zeroth order Quick procedure, proposed by Gou and Zhang (2020), with standard binary search enhancement.

(c) *quick01b*, the Quick procedure with refined d critical constants, with standard binary search enhancement.

(d) *quick10b*, the Quick procedure with refined c critical constants, with standard binary search enhancement.

(e) *quick11b*, the Quick procedure with refined c and d critical constants, with standard binary search enhancement.

(f) *quickxb*, the exact Quick procedure with refined c critical constants, with standard binary search enhancement.

(g) *quick00i*, the zeroth order Quick procedure, proposed by Gou and Zhang (2020), with interpolation search enhancement.

(h) *quick01i*, the Quick procedure with refined d critical constants, with interpolation search enhancement.

(i) *quick10i*, the Quick procedure with refined c critical constants, with interpolation search enhancement.

(j) *quick11i*, the Quick procedure with refined c and d critical constants, with interpolation search enhancement.

(k) *quickxi*, the exact Quick procedure with refined c critical constants, with interpolation search enhancement.

Value

a list, including a binary vector of rejections, the total number of comparisons, and an indicator of consonance.

Author(s)

Jiangtao Gou

References

Holm, S. (1979). A simple sequentially rejective multiple test procedure. *Scandinavian Journal of Statistics* **6**, 65-70.

Hochberg, Y. and Tamhane, A. C. (1987). Multiple Comparison Procedures. John Wiley and Sons, New York.

Hochberg, Y. (1988). A sharper Bonferroni procedure for multiple tests of significance. *Biometrika* **75**, 800-802.

Hommel, G. (1988). A stagewise rejective multiple test procedure based on a modified Bonferroni test. *Biometrika* **75**, 383-386.

Rom, D. M. (1990). A sequentially rejective test procedure based on a modified Bonferroni inequality. *Biometrika* **77**, 663-665.

Wright, S. P. (1992). Adjusted p-values for simultaneous inference. *Biometrics* **48**, 1005-1013.

Gou, J., Tamhane, A. C., Xi, D., and Rom, D. (2014). A class of improved hybrid Hochberg-Hommel type step-up multiple test procedures. *Biometrika* **101**, 899-911.

Gou, J., and Tamhane, A. C. (2014). On generalized Simes critical constants. *Biometrical Journal* **56**, 1035-1054.

Gou, J., and Tamhane, A. C. (2018). Hochberg procedure under negative dependence. *Statistica Sinica* **28**, 339-362.

Tamhane, A. C., and Gou, J. (2018). Advances in p-value based multiple test procedures. *Journal of Biopharmaceutical Statistics* **28**, 10-27.

Meijer, R. J., Krebs, T. J. P., and Goeman, J. J. (2019). Hommel's procedure in linear time. *Biometrical Journal* **61**, 73-82.

Tamhane, A. C., and Gou, J. (2022). Chapter 2 Multiple test procedures based on p-values. In X. Cui, T. Dickhaus, Y. Ding, and J. C. Hsu (Eds.), *Handbook of multiple comparisons* (Vol. 45, pp. 11-34).

Gou, J.(2022). Quick multiple test procedures and p-value adjustments, *Statistics in Biopharmaceutical Research* **14**, 636-650.

See Also

```
elitism::p.adjust
```

Examples

```
library(elitism)
 pvalues.raw <- c(0.002,0.007,0.005,0.024,0.022,0.009,0.007,0.036,0.060,0.035)
 pkev <- new.env(); pkev$global.count.IS <- 0; pkev$global.count.FS <- 0;
 decision.hoch <- mtp(pvalues.raw, alpha = 0.025, method = "hochberg")
 pkev <- new.env(); pkev$global.count.IS <- 0; pkev$global.count.FS <- 0;
 decision.quick <- mtp(pvalues.raw, alpha = 0.025, method = "quick")
 pkev <- new.env(); pkev$global.count.IS <- 0; pkev$global.count.FS <- 0;
 decision.gtxr <- mtp(pvalues.raw, alpha = 0.025, method = "gtxr")
```

---

mtp.wt *Multiple Test Procedures with known true significances and non-significances*

Description

Given a set of p-values, a set of indicators whether the corresponding hypothesis is true significance or true null, and the level of significance, returns a summary of false/true positive/negative, including the hybrid Hochberg-Hommel procedure (Gou et al., 2014) and Quick procedure (Gou and Zhang, 2022).

Usage

```
mtp.wt(p, indctr.sig, alpha = 0.05, method = "gtxr", n = length(p))
```

Arguments

p	vector of p-values.
indctr.sig	vector of indicators, 1 stands for true significance and 0 stands for true null.
alpha	the level of significance.
method	multiplicity correction method, including the Holm procedure ("holm"), the Hochberg procedure ("hochberg", "chochberg"), the Hommel procedure ("hommel", "hommelq", "hommell", "hommellsi", "hommellsb"), the Rom procedure ("rom", "rom1", "roma", "romx"), the Gou-Tamhane-Xi-Rom procedure ("gtxr", "gtxr0i", "gtxr1ci", "gtxr2di", "gtxr0b", "gtxr1cb", "gtxr2db"), and the Quick procedure ("quick", "quick00i", "quick01i", "quick10i", "quick11i", "quickxi", "quick00b", "quick01b", "quick10b", "quick11b", "quickxb").
n	number of p-values.

Details

Given a set of p-values with a binary vector of true signficances, where 1 stands for true significances, and 0 stands for true nulls. There are six families of procedures.

1. Holm procedure (1 procedure)
   (a) *holm*, the Holm (1979) step-down method.
2. Hochberg procedure (2 procedures)
   (a) *hochberg*, the Hochberg (1988) step-up method.
   (b) *chochberg*, the conservative Hochberg method developed by Gou and Tamhane (2018).
3. Hommel procedure (5 procedures)
   (a) *hommel*, the Hommel (1988) step-up method, linear time algorithm with standard binary search, equivalent to *hommellsb*.
   (b) *hommelq*, the Hommel (1988) step-up method, quadratic time algorithm.
   (c) *hommell*, the Hommel (1988) step-up method, linear time algorithm by Meijer, Krebs and Goeman (2019).
   (d) *hommellsb*, the Hommel (1988) step-up method, linear time algorithm by Meijer, Krebs and Goeman (2019), with standard binary search enhancement.
   (e) *hommellsi*, the Hommel (1988) step-up method, linear time algorithm by Meijer, Krebs and Goeman (2019), with interpolation search enhancement.
4. Rom procedure (4 procedure)
   (a) *rom*, the Rom (1990) step-up method, equivalent to *romx*.
   (b) *rom1*, the Rom-1 method proposed by Gou and Zhang (2020).
   (c) *roma*, the Rom-1A method proposed by Gou and Zhang (2020).
   (d) *romx*, the Rom (1990) step-up method.
5. Gou-Tamhane-Xi-Rom procedure (7 procedure)
   (a) *gtxr*, the zeroth order hybrid Hommel-Hochberg procedure, proposed by Gou et al. (2014), equivalent to *gtxr0b*.
   (b) *gtxr0b*, the zeroth order GTXR procedure, with standard binary search enhancement.
   (c) *gtxr1cb*, the GTXR procedure with refined c critical constants, with standard binary search enhancement.
   (d) *gtxr2db*, the GTXR procedure with refined d critical constants, with standard binary search enhancement.
   (e) *gtxr0i*, the zeroth order GTXR procedure, with interpolation search enhancement.
   (f) *gtxr1ci*, the GTXR procedure with refined c critical constants, with interpolation search enhancement.
   (g) *gtxr2di*, the GTXR procedure with refined d critical constants, with interpolation search enhancement.
6. Quick procedure (11 procedure)
   (a) *quick*, the Quick method, proposed by Gou and Zhang (2020), equivalent to *quick00b*.
   (b) *quick00b*, the zeroth order Quick procedure, proposed by Gou and Zhang (2020), with standard binary search enhancement.
   (c) *quick01b*, the Quick procedure with refined d critical constants, with standard binary search enhancement.

(d) *quick10b*, the Quick procedure with refined c critical constants, with standard binary search enhancement.

(e) *quick11b*, the Quick procedure with refined c and d critical constants, with standard binary search enhancement.

(f) *quickxb*, the exact Quick procedure with refined c critical constants, with standard binary search enhancement.

(g) *quick00i*, the zeroth order Quick procedure, proposed by Gou and Zhang (2020), with interpolation search enhancement.

(h) *quick01i*, the Quick procedure with refined d critical constants, with interpolation search enhancement.

(i) *quick10i*, the Quick procedure with refined c critical constants, with interpolation search enhancement.

(j) *quick11i*, the Quick procedure with refined c and d critical constants, with interpolation search enhancement.

(k) *quickxi*, the exact Quick procedure with refined c critical constants, with interpolation search enhancement.

Value

a list, including five integers and a binary indicator: number of false positives, number of true negatives, number of true positives, number of false negatives, the number of total comparisons, and an indicator of consonance.

Author(s)

Jiangtao Gou

Fengqing (Zoe) Zhang

References

Holm, S. (1979). A simple sequentially rejective multiple test procedure. *Scandinavian Journal of Statistics* **6**, 65-70.

Hochberg, Y. and Tamhane, A. C. (1987). Multiple Comparison Procedures. John Wiley and Sons, New York.

Hochberg, Y. (1988). A sharper Bonferroni procedure for multiple tests of significance. *Biometrika* **75**, 800-802.

Hommel, G. (1988). A stagewise rejective multiple test procedure based on a modified Bonferroni test. *Biometrika* **75**, 383-386.

Rom, D. M. (1990). A sequentially rejective test procedure based on a modified Bonferroni inequality. *Biometrika* **77**, 663-665.

Wright, S. P. (1992). Adjusted p-values for simultaneous inference. *Biometrics* **48**, 1005-1013.

Gou, J., Tamhane, A. C., Xi, D., and Rom, D. (2014). A class of improved hybrid Hochberg-Hommel type step-up multiple test procedures. *Biometrika* **101**, 899-911.

Gou, J., and Tamhane, A. C. (2014). On generalized Simes critical constants. *Biometrical Journal* **56**, 1035-1054.

Gou, J., and Tamhane, A. C. (2018). Hochberg procedure under negative dependence. *Statistica Sinica* **28**, 339-362.

Tamhane, A. C., and Gou, J. (2018). Advances in p-value based multiple test procedures. *Journal of Biopharmaceutical Statistics* **28**, 10-27.

Meijer, R. J., Krebs, T. J. P., and Goeman, J. J. (2019). Hommel's procedure in linear time. *Biometrical Journal* **61**, 73-82.

Tamhane, A. C., and Gou, J. (2022). Chapter 2 Multiple test procedures based on p-values. In X. Cui, T. Dickhaus, Y. Ding, and J. C. Hsu (Eds.), *Handbook of multiple comparisons* (Vol. 45, pp. 11-34).

Gou, J.(2022). Quick multiple test procedures and p-value adjustments, *Statistics in Biopharmaceutical Research* **14**, 636-650.

See Also

`elitism::mtp`

Examples

```
library(elitism)
 pvalues.raw <- c(0.002,0.007,0.005,0.024,0.022,0.009,0.007,0.036,0.060,0.035)
 indctr.sig <- c(1, 0, 0, 0, 1,  1, 1, 1, 0, 0)
 pkev <- new.env(); pkev$global.count.IS <- 0; pkev$global.count.FS <- 0;
 summary.hoch <- mtp.wt(pvalues.raw, indctr.sig, alpha = 0.025, method = "hochberg")
 pkev <- new.env(); pkev$global.count.IS <- 0; pkev$global.count.FS <- 0;
 summary.quick <- mtp.wt(pvalues.raw, indctr.sig, alpha = 0.025, method = "quick")
 pkev <- new.env(); pkev$global.count.IS <- 0; pkev$global.count.FS <- 0;
 summary.gtxr <- mtp.wt(pvalues.raw, indctr.sig, alpha = 0.025, method = "gtxr")
```

`p.adjust` *Adjust P-values for Multiple Test Procedures*

Description

Given a set of p-values, returns adjusted p-values, including the hybrid Hochberg-Hommel procedure (Gou et al., 2014) and Quick procedure (Gou and Zhang, 2022).

Usage

```
p.adjust(p, method = "gtxr", n = length(p))
```

Arguments

`p`	vector of p-values.
`method`	multiplicity correction method, "gtxr" is the hybrid Hochberg-Hommel method, "quick" is the Quick method. Other methods include:"holm", "hochberg", "hommel", "bonferroni", "BH", "BY","fdr", "none" from the standard R function p.adjust.
`n`	number of p-values.

Details

Given a set of p-values, returns p-values adjusted using one of several methods. The default method is "gtxr". Another option is "quick". Other adjustment methods have been included in function p.adjust in R package stats.

Value

a vector of corrected p-values.

Author(s)

Jiangtao Gou

References

Gou, J., Tamhane, A. C., Xi, D., and Rom, D. (2014). A class of improved hybrid Hochberg-Hommel type step-up multiple test procedures. *Biometrika* **101**, 899-911.

Tamhane, A. C., and Gou, J. (2018). Advances in p-value based multiple test procedures. *Journal of Biopharmaceutical Statistics* **28**, 10-27.

Tamhane, A. C., and Gou, J. (2022). Chapter 2 Multiple test procedures based on p-values. In X. Cui, T. Dickhaus, Y. Ding, and J. C. Hsu (Eds.), *Handbook of multiple comparisons* (Vol. 45, pp. 11-34).

Gou, J.(2022). Quick multiple test procedures and p-value adjustments, *Statistics in Biopharmaceutical Research* **14**, 636-650.

See Also

`stats::p.adjust`

Examples

```
library(elitism)
 pvalues.raw <- c(0.002,0.007,0.005,0.024,0.022,0.009,0.007,0.036,0.060,0.035)
 p.adj.hoch <- elitism::p.adjust(pvalues.raw, method = "hochberg")
 p.adj.quick <- elitism::p.adjust(pvalues.raw, method = "quick")
 p.adj.gtxr <- elitism::p.adjust(pvalues.raw, method = "gtxr")
```

Index