

Introduction to BonEV package

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1 Overview

This document provides an introduction to the **BonEV** package. The **BonEV** package calculates the adjusted P-values from user-provided raw P-values through the Bon-EV multiple testing procedure that controls the false discovery rates at user-defined level alpha. The Bon-EV multiple testing procedure is developed based on the Bonferroni procedure with integrated estimates from the Benjamini-Hochberg procedure and the Storey's q-value procedure. It controls false discovery rates through controlling the expected number of false discoveries.

2 Getting started

The **BonEV** package can be installed and loaded through the following R code. Install the **BonEV** package with:

```
> install.packages("BonEV")
```

Load the **BonEV** package with:

```
> library(BonEV)
```

3 Bon_EV function

There is one function in the **BonEV** package: **Bon_EV**. The function requires raw P-values in the vector format and user-defined alpha level for false discovery rates control. **Bon_EV** will generate adjusted

P-values from the Bon-EV multiple testing procedure that is developed based on the Bonferroni procedure with integrated estimates from the Benjamini-Hochberg procedure and the Storey's q-value procedure. `Bon_EV` controls false discovery rates through controlling the expected number of false discoveries.

The following is an example using the `Bon_EV` function. The raw P-values in the `hedenfalk` data set from the `qvalue` package are used as the input to get adjusted P-values from the Bon-EV multiple testing procedure with the false discovery rate controlled at level $\alpha = 0.05$. Then, the adjusted P-values from the Bon-EV multiple testing procedure are compared with adjusted P-values obtained from the Benjamini-Hochberg and Storey's q-value procedures.

```
> library(qvalue)
> data(hedenfalk)
> library(BonEV)
> pvalues <- hedenfalk$p
> adjp <- Bon_EV(pvalues, 0.05)
> summary(adjp)
```

	Length	Class	Mode
raw_P_value	3170	-none-	numeric
BH_adjp	3170	-none-	numeric
Storey_adjp	3170	-none-	numeric
Bon_EV_adjp	3170	-none-	numeric

```
> results <- cbind(adjp$raw_P_value, adjp$BH_adjp, adjp$Storey_adjp, adjp$Bon_EV_adjp)
> colnames(results) <- c("raw_P_value", "BH_adjp", "Storey_adjp", "Bon_EV_adjp")
> results[1:20,]
```

	raw_P_value	BH_adjp	Storey_adjp	Bon_EV_adjp
[1,]	0.0121261830	0.13164384	0.08819163	0.27395698
[2,]	0.0750252366	0.31252300	0.20936729	1.00000000
[3,]	0.9949211356	0.99712298	0.66799864	1.00000000
[4,]	0.0417854890	0.24127505	0.16163643	0.94402555
[5,]	0.8458138801	0.94409507	0.63247386	1.00000000
[6,]	0.2519242902	0.55487215	0.37172329	1.00000000
[7,]	0.6586561514	0.85571311	0.57326449	1.00000000
[8,]	0.0656813880	0.29288112	0.19620868	1.00000000
[9,]	0.1232681388	0.40326109	0.27015510	1.00000000
[10,]	0.0007129338	0.03455882	0.02315186	0.01610673
[11,]	0.0883974763	0.34467564	0.23090718	1.00000000
[12,]	0.0073817035	0.10263158	0.06875557	0.16676882
[13,]	0.2710000000	0.56872932	0.38100657	1.00000000
[14,]	0.9749810726	0.99124118	0.66405827	1.00000000
[15,]	0.2497097792	0.55277933	0.37032126	1.00000000
[16,]	0.7734763407	0.91832210	0.61520787	1.00000000
[17,]	0.0361829653	0.22569472	0.15119876	0.81745229
[18,]	0.0017507886	0.05441176	0.03645186	0.03955414

```
[19,] 0.0884668770 0.34467564 0.23090718 1.00000000
[20,] 0.1380883281 0.42947059 0.28771352 1.00000000
```

```
> summary(results)
```

raw_P_value	BH_adj	Storey_adj	Bon_EV_adj
Min. :0.0000032	Min. :0.0100	Min. :0.006699	Min. :0.0000713
1st Qu.:0.0845647	1st Qu.:0.3379	1st Qu.:0.226394	1st Qu.:1.0000000
Median :0.2998155	Median :0.5993	Median :0.401516	Median :1.0000000
Mean :0.3718702	Mean :0.5764	Mean :0.386171	Mean :0.8831296
3rd Qu.:0.6316112	3rd Qu.:0.8418	3rd Qu.:0.563918	3rd Qu.:1.0000000
Max. :0.9998517	Max. :0.9999	Max. :0.669827	Max. :1.0000000

```
> ##Compare with Benjami-Hochberg and Storey's q-value procedures
```

```
> sum(adjp$raw_P_value <= 0.05)
```

```
[1] 606
```

```
> sum(adjp$BH_adj <= 0.05)
```

```
[1] 94
```

```
> sum(adjp$Storey_adj <= 0.05)
```

```
[1] 162
```

```
> sum(adjp$Bon_EV_adj <= 0.05)
```

```
[1] 120
```