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Benjamini-Hochberg Procedure

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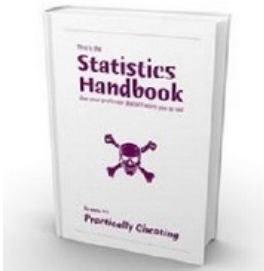
What is the Benjamini-Hochberg Procedure?

The Benjamini-Hochberg Procedure is a powerful tool that decreases the false discovery rate.

Adjusting the rate helps to control for the fact that sometimes small p-values (less than 5%) happen by chance, which could lead you to incorrectly reject the true null hypotheses. In other words, the B-H Procedure helps you to avoid Type I errors (false positives).

A p-value of 5% means that there's only a 5% chance that you would get your observed result *if* the null hypothesis were true. In other words, if you get a p-value of 5%, it's highly unlikely that your null hypothesis is not true and should be thrown out. But it's only a probability–many times, true null hypotheses are thrown out just because of the randomness of results.

A concrete example: Let's say you have a group of 100 patients who you know are free of a certain disease. Your null hypothesis is that the patients are free of disease and your alternate is that they *do* have the disease. If you ran 100 statistical tests at the 5% alpha level, **roughly 5% of results would report as false positives.**

There's not a lot you can do to avoid this: **when you run statistical tests, a fraction will always be false positives.** However, running the B-H procedure will decrease the number of false positives.

How to Run the Benjamini–Hochberg procedure

1. Put the individual p-values in ascending order.
2. Assign ranks to the p-values. For example, the smallest has a rank of 1, the second smallest has a rank of 2.
3. Calculate each in
   - i = the indi
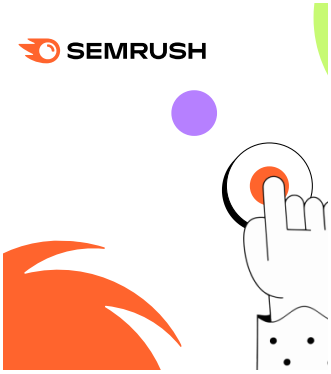   - m = total n
   - Q = the fals

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4. Compare your original p-values to the critical B-H from Step 3; find the largest p value that is smaller than the critical value.

As an example, the following list of data shows a **partial list of results from 25 tests** with their p-values in column 2. The list of p-values was ordered (Step 1) and then ranked (Step 2) in column 3. Column 4 shows the calculation for the critical value with a false discovery rate of 25% (Step 3). For instance, column 4 for item 1 is calculated as (1/25) * .25 = 0.01:

Variable	P Value	Rank	(I/m)Q
Depression	0.001	1	0.01
Family History	0.008	2	0.02
Obesity	0.039	3	0.03
Other health	0.041	4	0.04
Children	**0.042**	**5**	**0.05**
Divorce	0.060	6	0.06
Death of Spouse	0.074	7	0.07
Limited income	0.205	8	0.08

The bolded p-value (for Children) is the highest p-value that is also smaller than the critical value: .042 < .050. **All** values above it (i.e. those with lower p-values) are highlighted and considered significant, even if those p-values are lower than the critical values. For example, Obesity and Other Health are individually, not significant when you compare the result to the final column (e.g. .039 > .03). However, with the B-H correction, they are considered significant; in other words, you would reject the null hypothesis for those values.

References

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