

P-values

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P-values are popular

If he was cited every time a p-value was reported his paper would have, at the very least, 3 million citations* - making it the most highly cited paper of all time.

0.6
P-values and hypothesis testing
get a bad rap - but we
sometimes find them useful.
POSTED BY AD
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The most written by Jeff Leek and Rafa Irizarry.

The **p-value** is the most widely-known statistic. P-values are reported in a large majority of scientific publications that measure and report data. **R.A. Fisher** is widely credited with inventing the p-value. If he was cited every time a p-value was reported his paper would have, at the very least, 3 **million** citations* - making it the **most highly cited paper** of all time.

However, the p-value has a large number of very vocal critics. The criticisms of p-values, and hypothesis testing more generally, range from philosophical to



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**Know what a p-value is ...
and isn't!**

The probability of observing a statistic that extreme if the null hypothesis is true.

The p-value is not

- Probability the null is true
- Probability the alternative is true
- A measure of statistical evidence

An example

Response	R	R	...	NR	NR
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	Patient 1	Patient 2	...	Patient n-1	Patient n
Gene 1	-1.64	-0.42	...	-1.39	-0.38
Gene 2	-3.12	-3.60	...	-3.80	-2.82
:	:	:	...	:	:
:	:	:	...	:	:
:	:	:	...	:	:
:	:	:	...	:	:

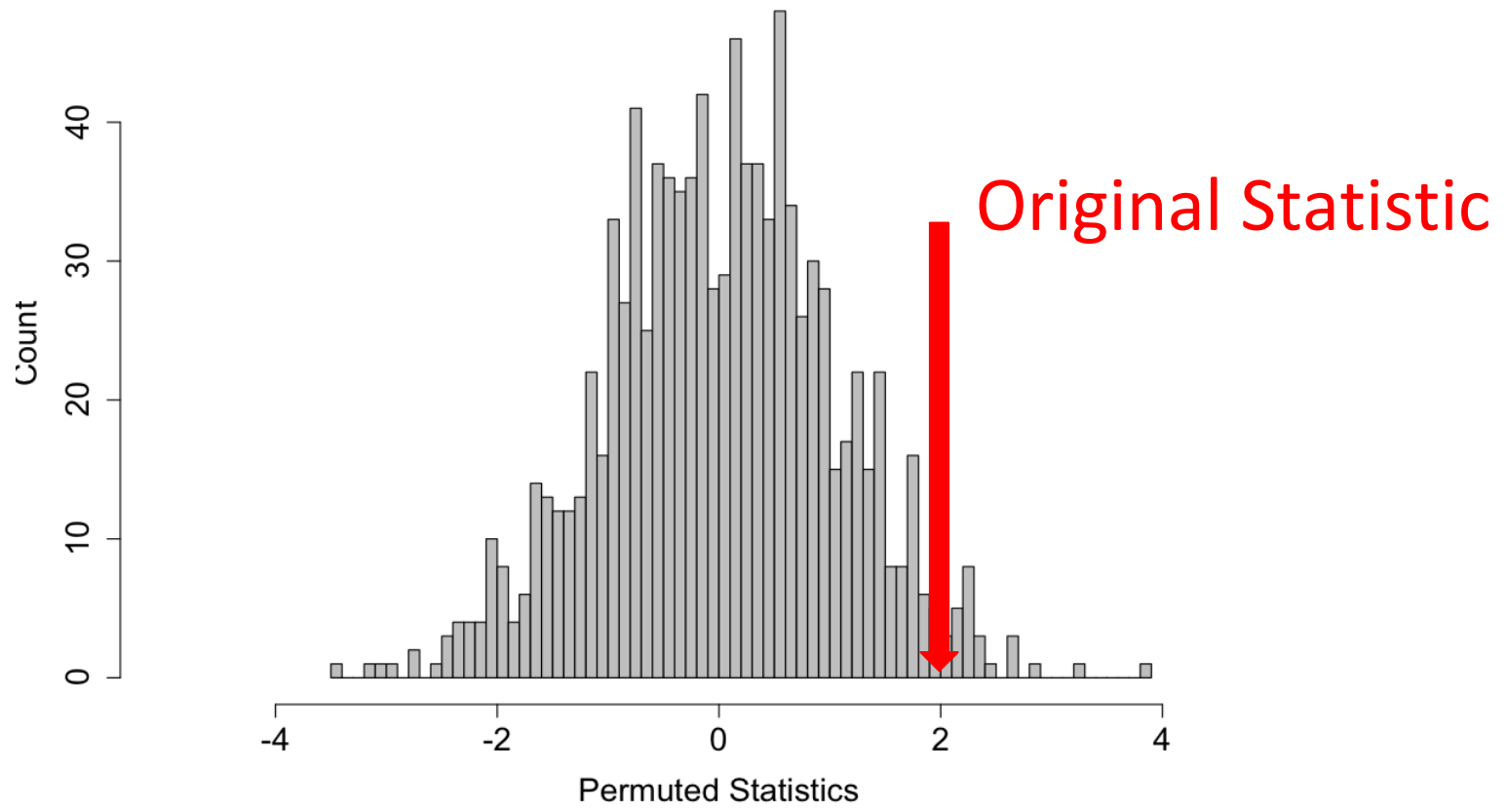
$$\frac{\bar{Y} - \bar{X}}{\sqrt{\frac{s_Y^2}{N} + \frac{s_X^2}{M}}}$$

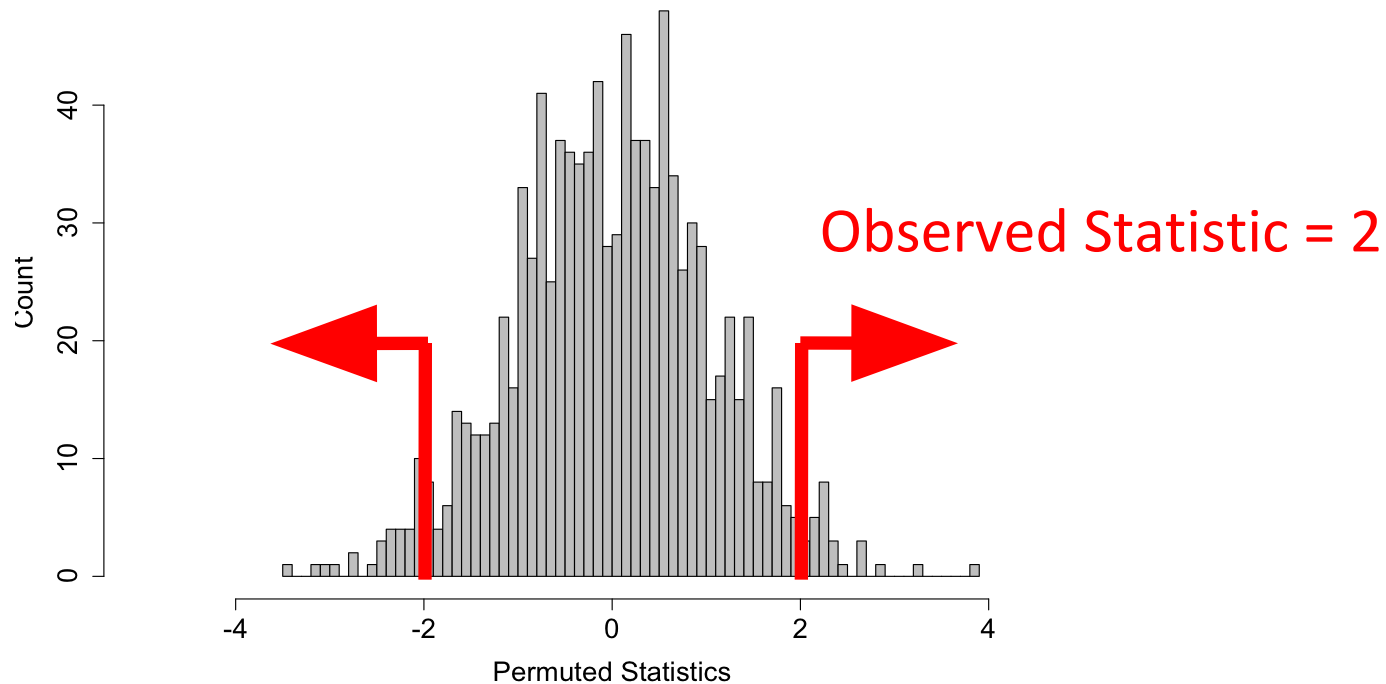


Response	R	R	...	NR	NR
	Patient 1	Patient 2	...	Patient n-1	Patient n
Gene 1	-1.64	-0.42	...	-1.39	-0.38
Gene 2	-3.12	-3.60	...	-3.80	-2.82
:	:	:	...	:	:
:	:	:	...	:	:
:	:	:	...	:	:
:	:	:	...	:	:
Gene m-1	-2.34	-0.22	...	-1.22	-2.76
Gene m	4.53	3.23	...	0.29	3.11

Response	NR	R	...	NR	R
	Patient 1	Patient 2	...	Patient n-1	Patient n
Gene 1	-1.64	-0.42	...	-1.39	-0.38
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:	:	:	...	:	:
:	:	:	...	:	:
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Gene m-1	-2.34	-0.22	...	-1.22	-2.76
Gene m	4.53	3.23	...	0.29	3.11

Leaves the relationship between genes unchanged.

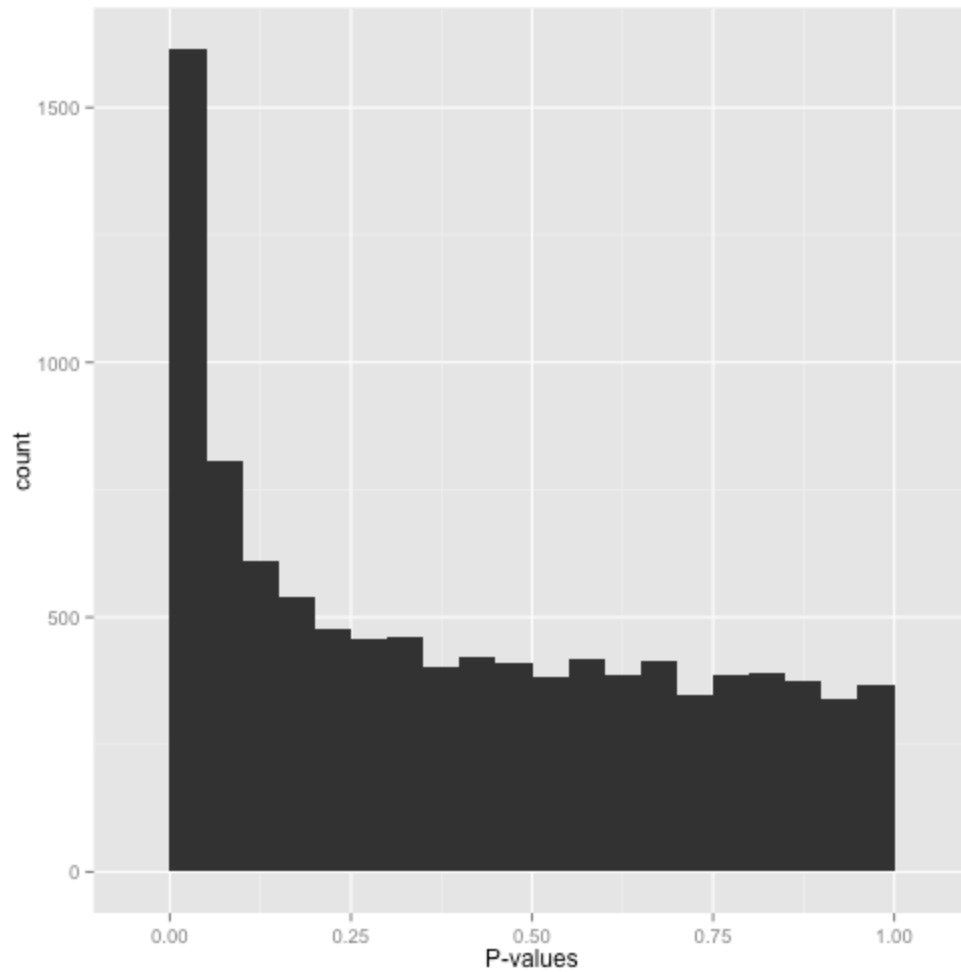




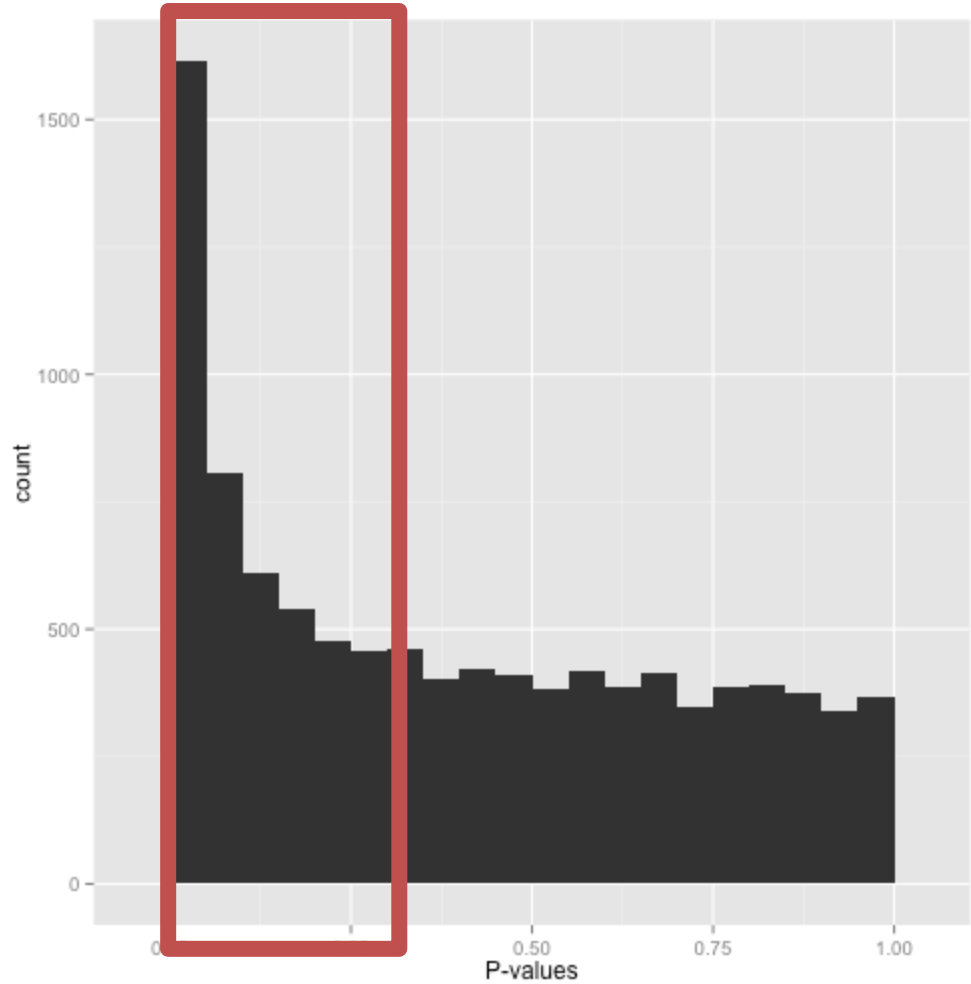
$$\{ \# \mid |S^{perm}| \geq |S^{obs}| \}$$

$$\text{P-value} = \frac{\quad}{\# \text{ of Permutations}}$$

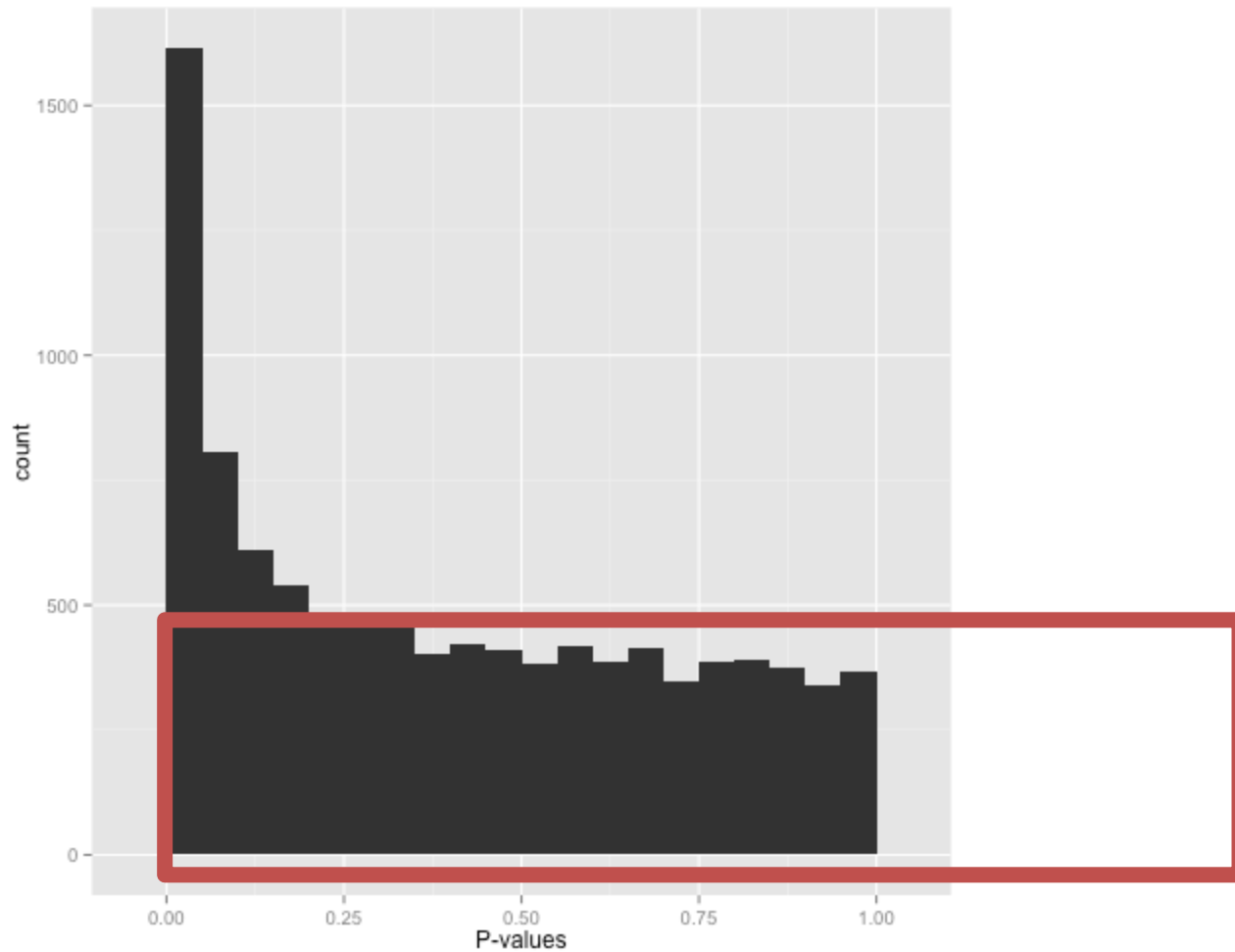
P-value properties



<http://varianceexplained.org/statistics/interpreting-pvalue-histogram/>

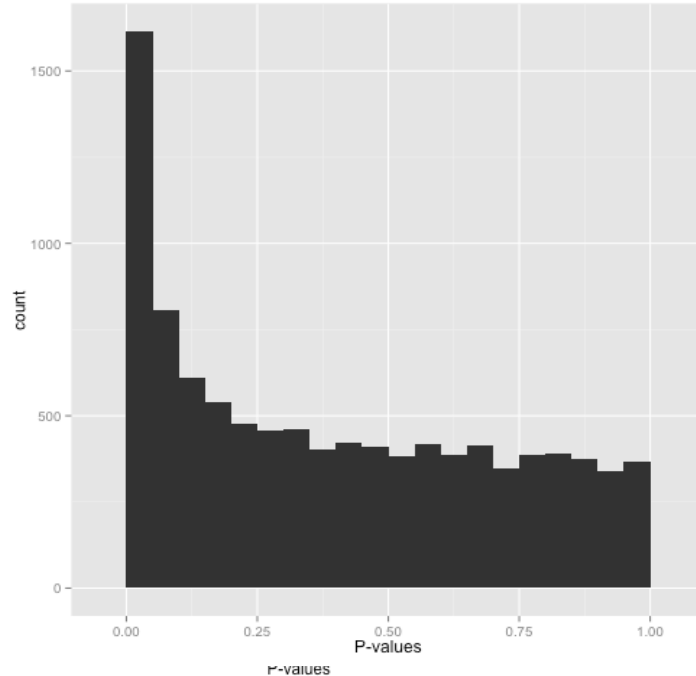


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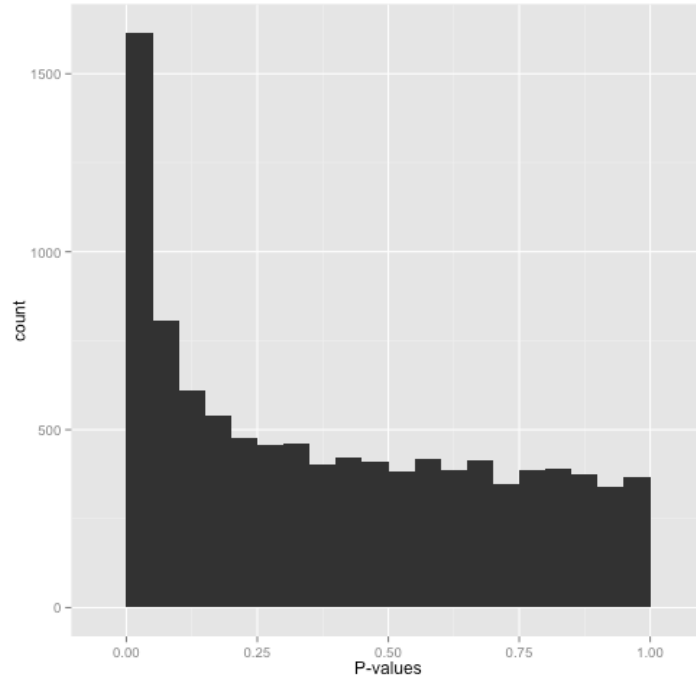
the two-groups model



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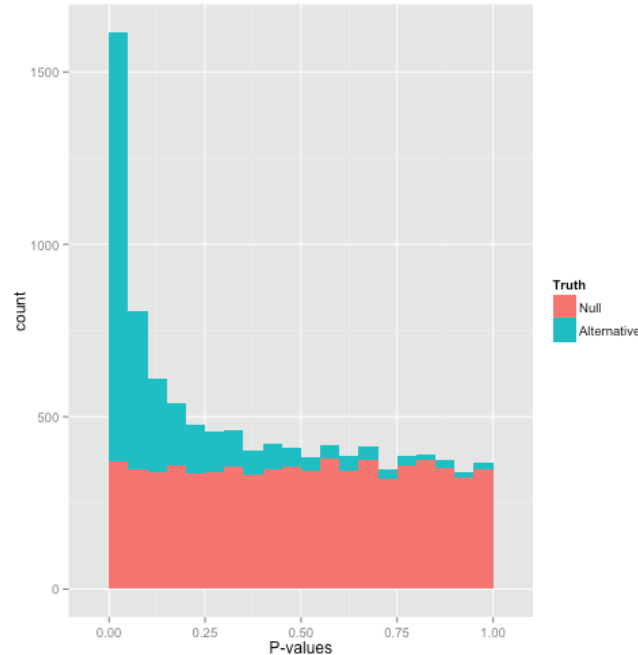
the two-groups model

$$p \sim \pi_0 f_0 + (1 - \pi_0) f_1$$



the two-groups model

$$p \sim \pi_0 f_0 + (1 - \pi_0) f_1$$



Notes and further reading

- P-values almost always go to zero with sample size
- The cutoff of 0.05 is a made up number
- These should be reported in conjunction with estimates/variances