P-value basics

- *Probability of observing a statistic equal to the one seen in the data, or one that is more "extreme", when the null hypothesis is true*

	Null hypothesis is true	**Null hypothesis is false**
Behaviour of a statistic		

P-value basics

- *Probability of observing a statistic equal to the one seen in the data, or one that is more "extreme", when the null hypothesis is true*

- Requires:
  - Knowledge of the null hypothesis
  - Choice of a statistic
  - Concept of repeating the whole study in the same way
    - Same study design
    - Same sampling scheme
    - Same definition of the statistic

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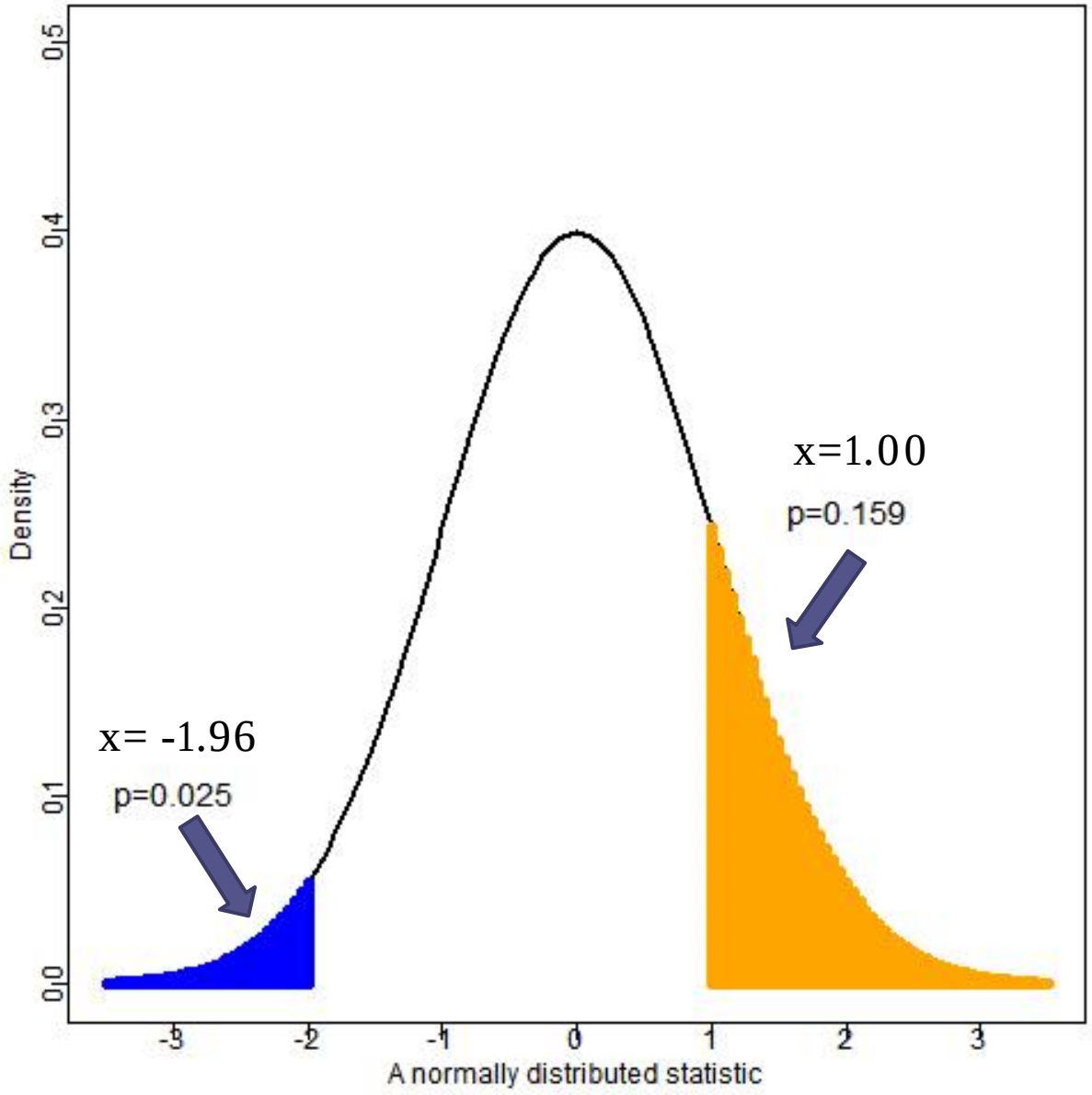
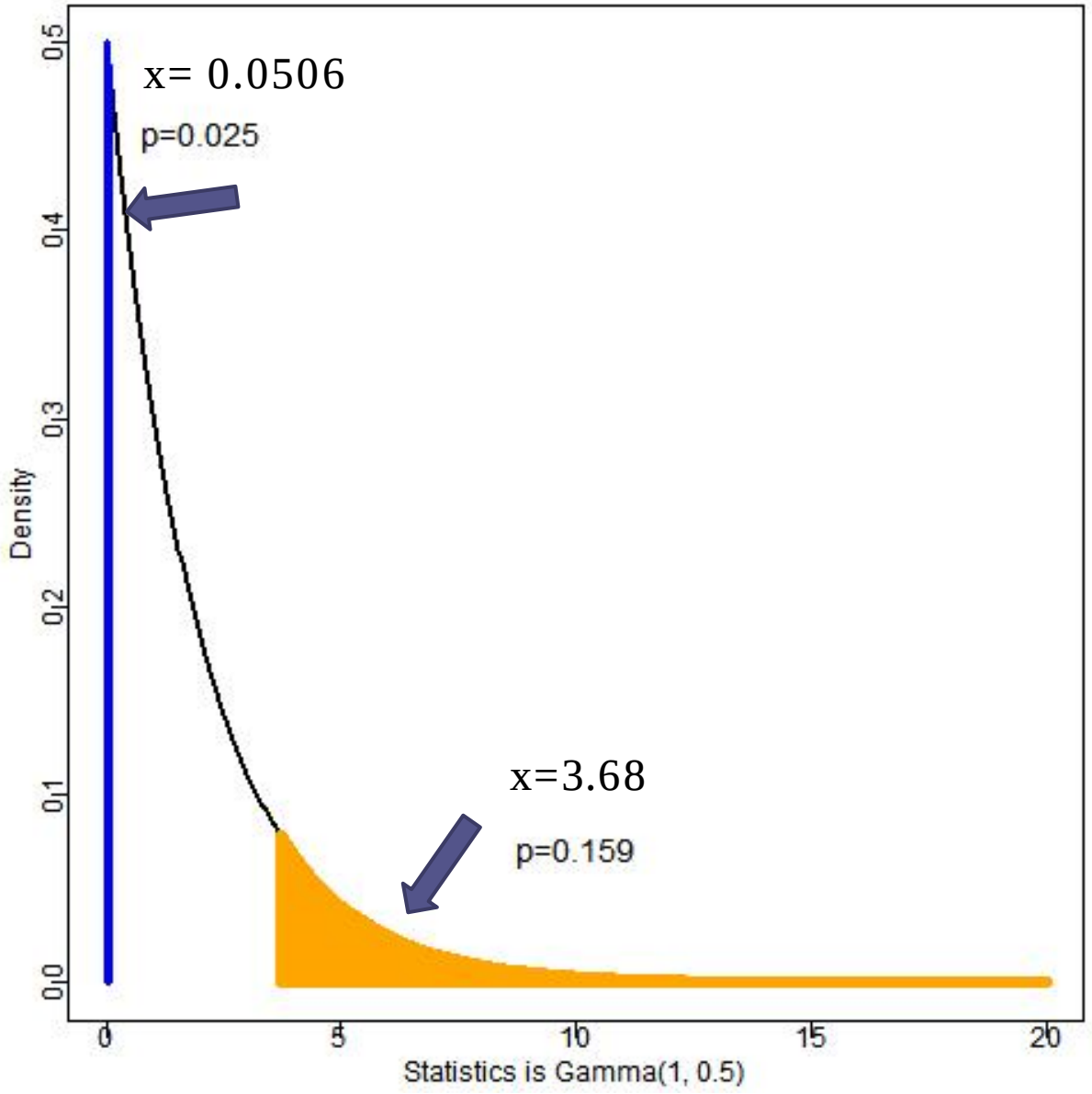
A normally distributed statistic



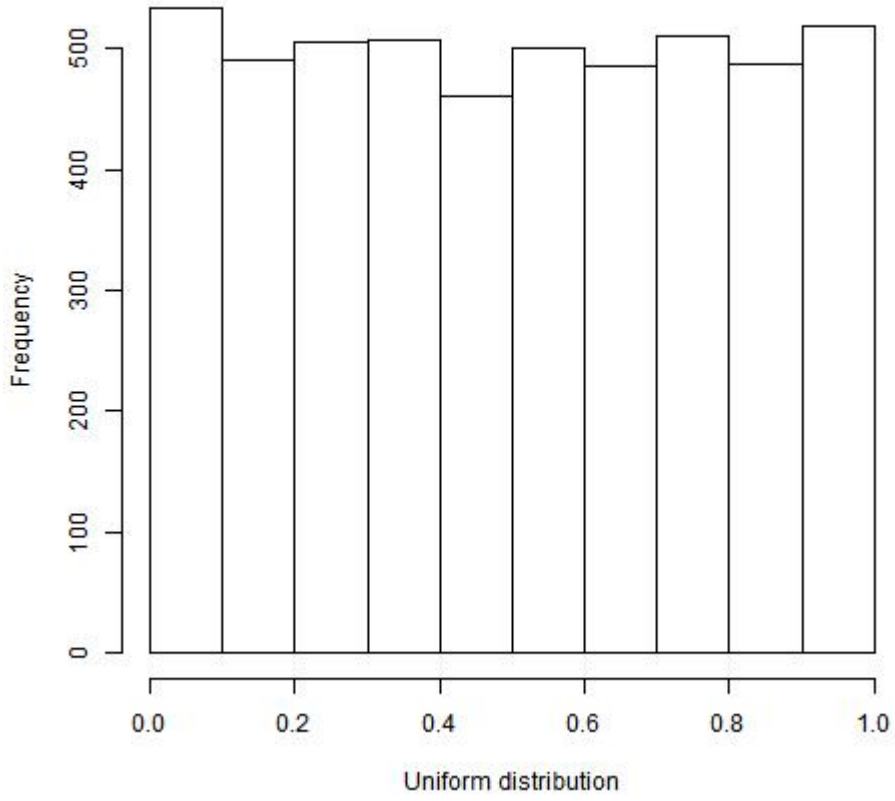
A gamma-distributed statistic

Gamma(1, 0.5)



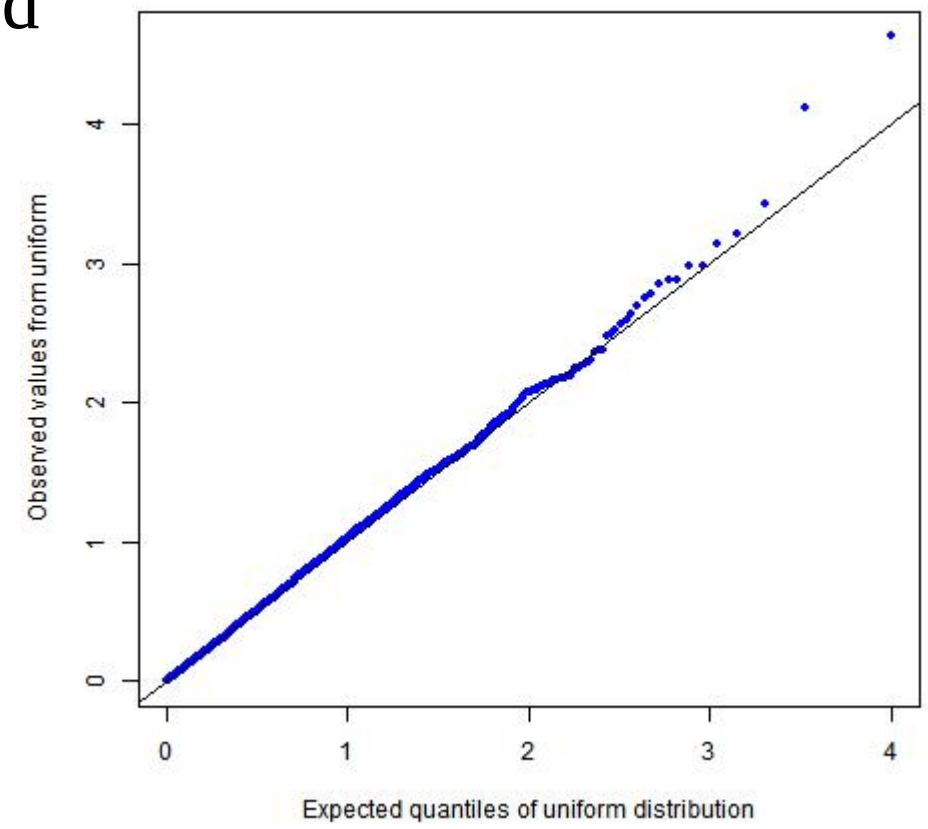
Uniform distribution

- P-values have a uniform distribution when the null hypothesis is true



QQ plot

- Observed vs. expected
- $-\log_{10}$ p-values



Basics of power

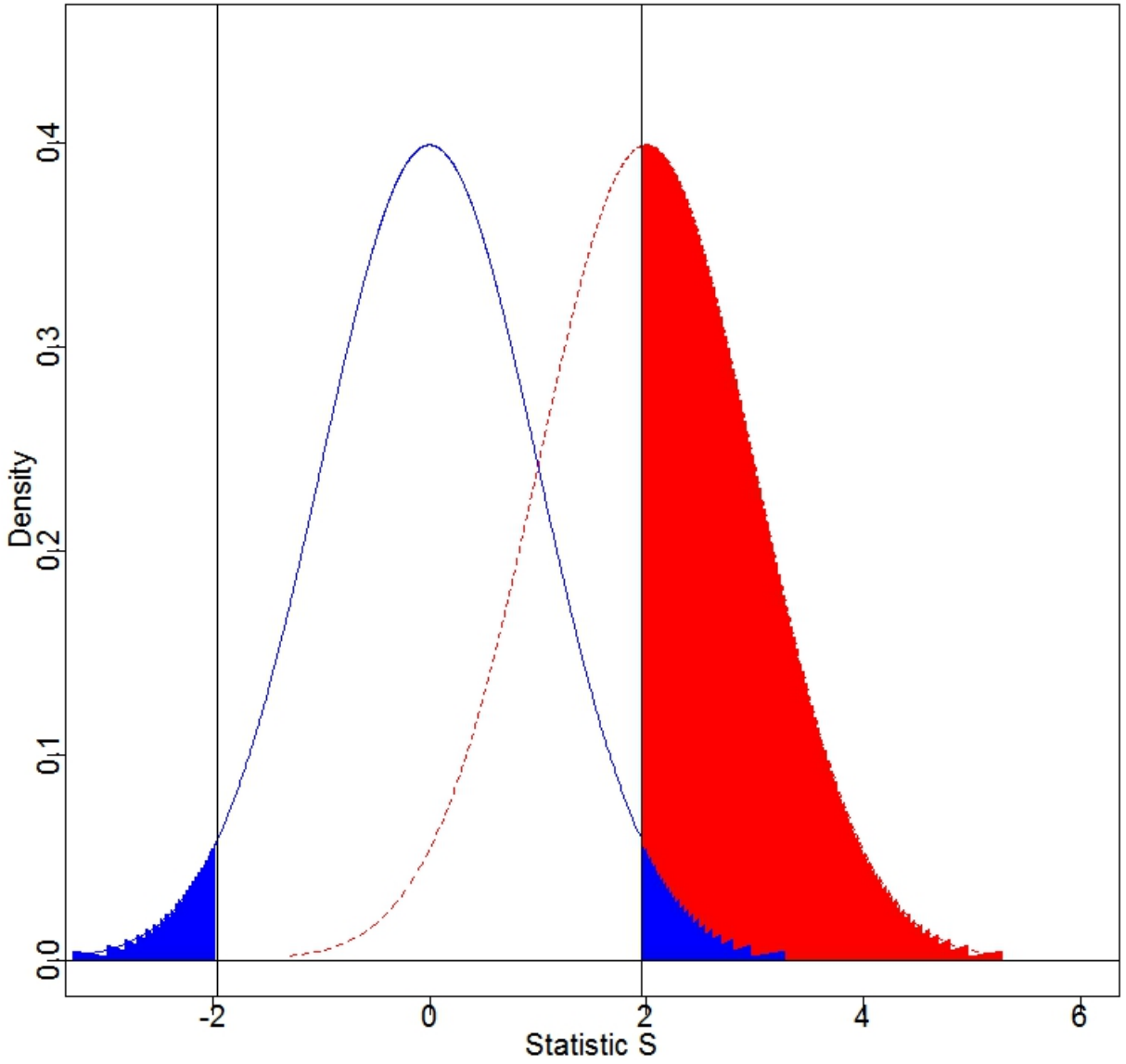
Decision based on a Statistic	Null hypothesis is true	Null hypothesis is false
Reject the null	α	$1-\beta$
Do not reject	$1-\alpha$	β

- Power: probability that the null is rejected when it is false
- α : Type 1 error
- β: Type 2 error

Power

Depends on 3 factors

- α
- β
- Effect size: i.e. the difference between the distributions



For example: the t-test comparing 2 groups

- Null hypothesis: two groups have the same mean
- The usual statistic is

$$\frac{(mean_1 - mean_2)}{sd_{pooled}\sqrt{1/n_1 + 1/n_2}}$$

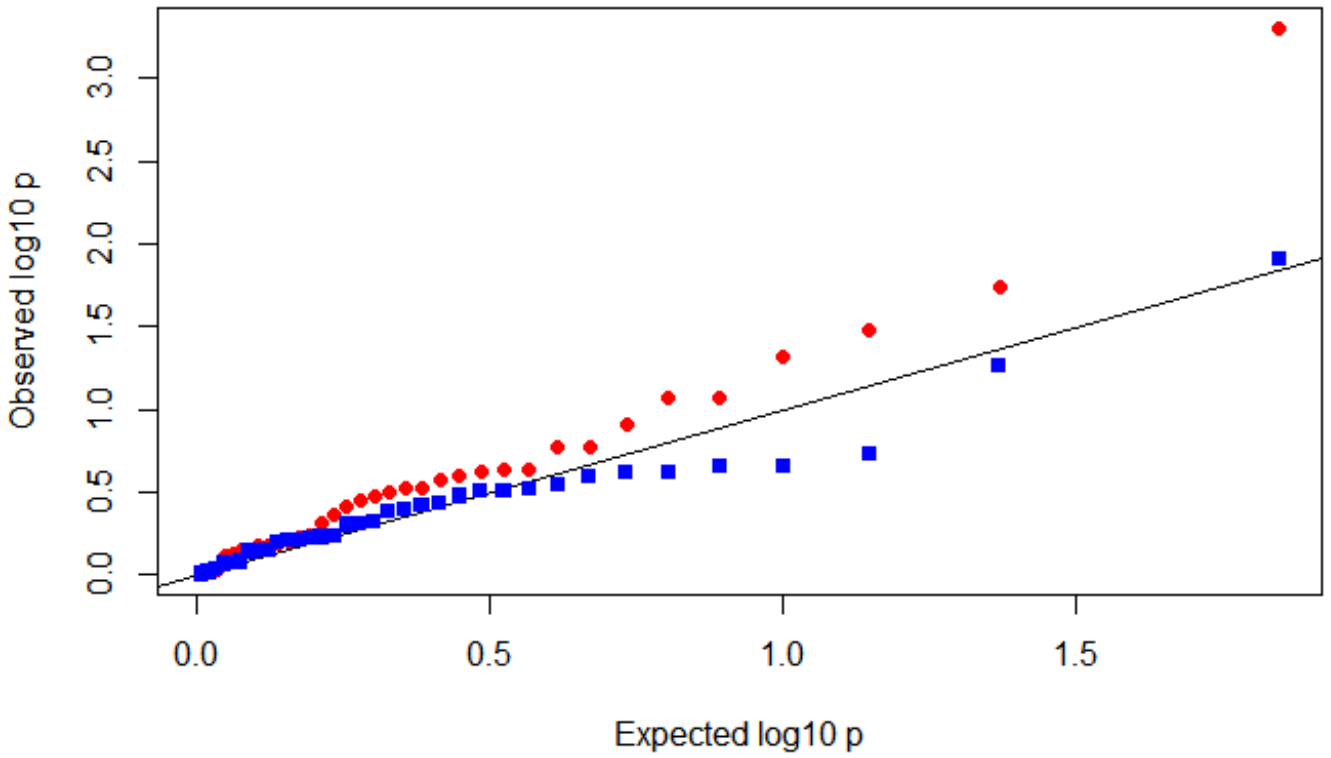
- Result implicitly assumes you are interested in a general phenomenon – i.e. *inference*
- Power varies with
  - How far apart are the means
  - Standard deviation (sd)

Now

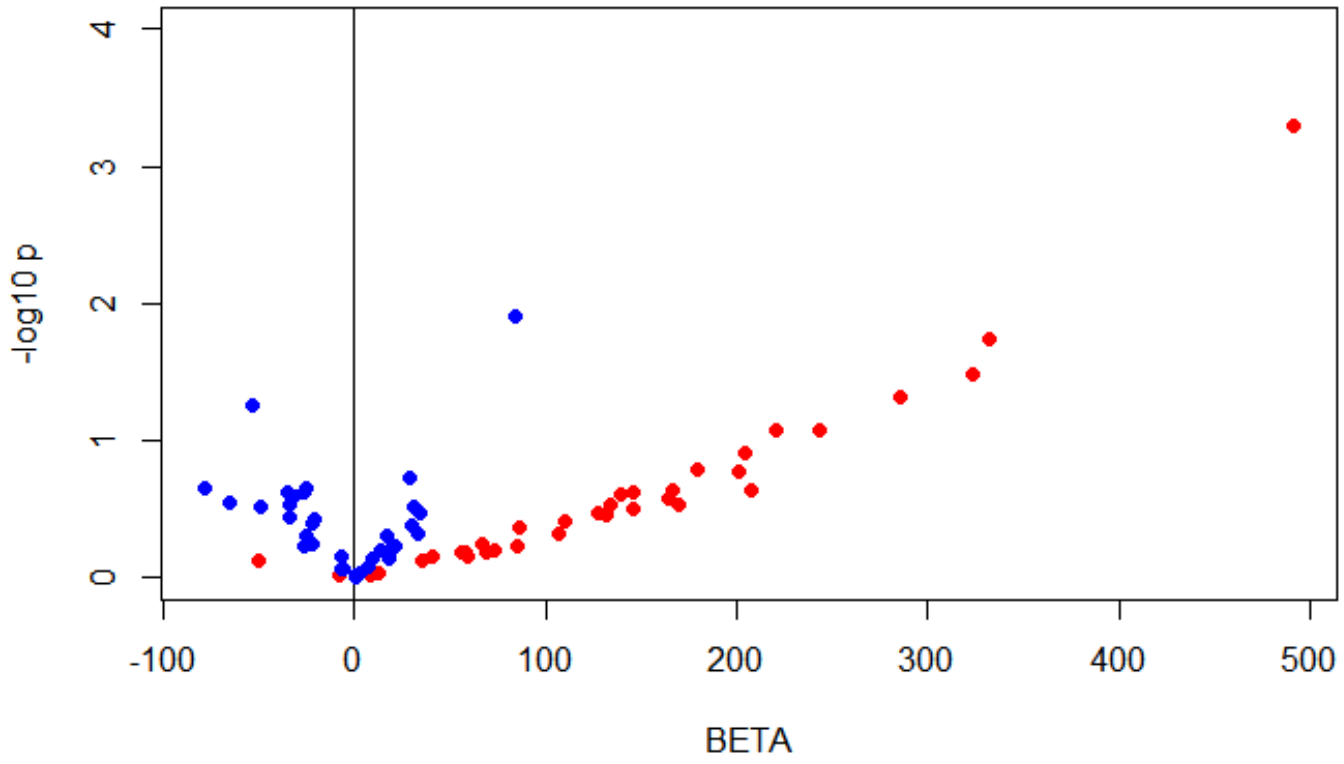
- Read in phenotypes.aug.csv
- Select 30 people
  - Test for association between parahippocampal cortical volume and GENDER
  - Test for association between parahippocampal volume and MYSTERY

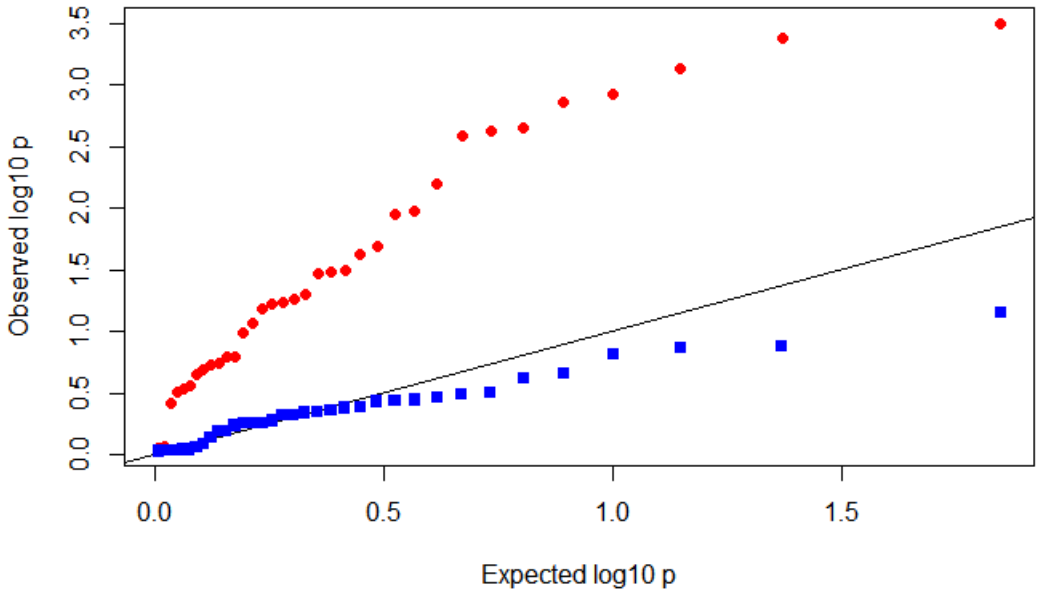
(pause)

QQ plot: N=30.
35 different datasets sampled
GENDER (red); MYSTERY (blue)

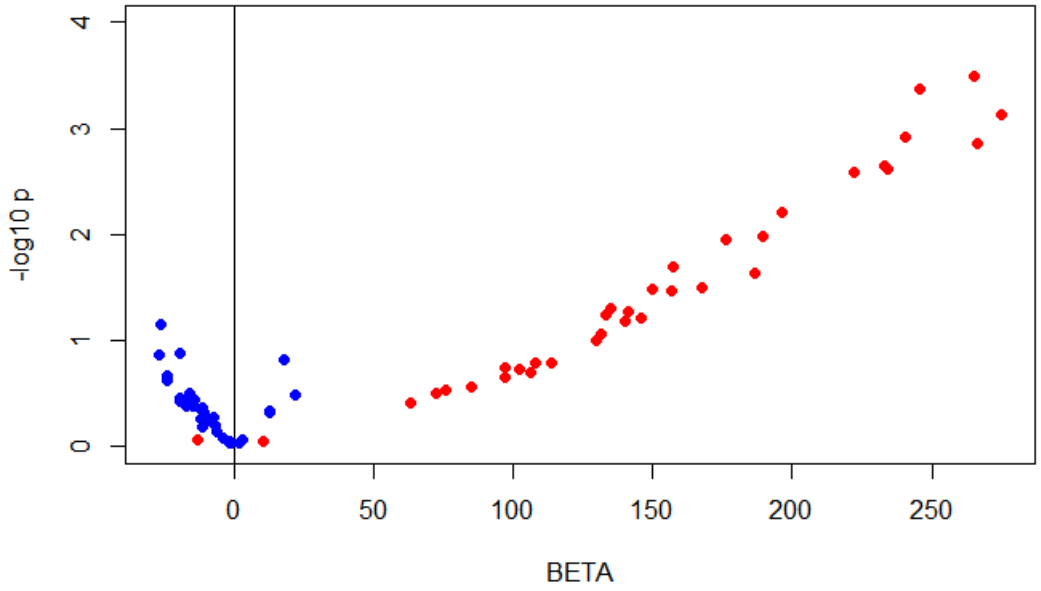


Volcano plot: N = 30
35 different datasets sampled

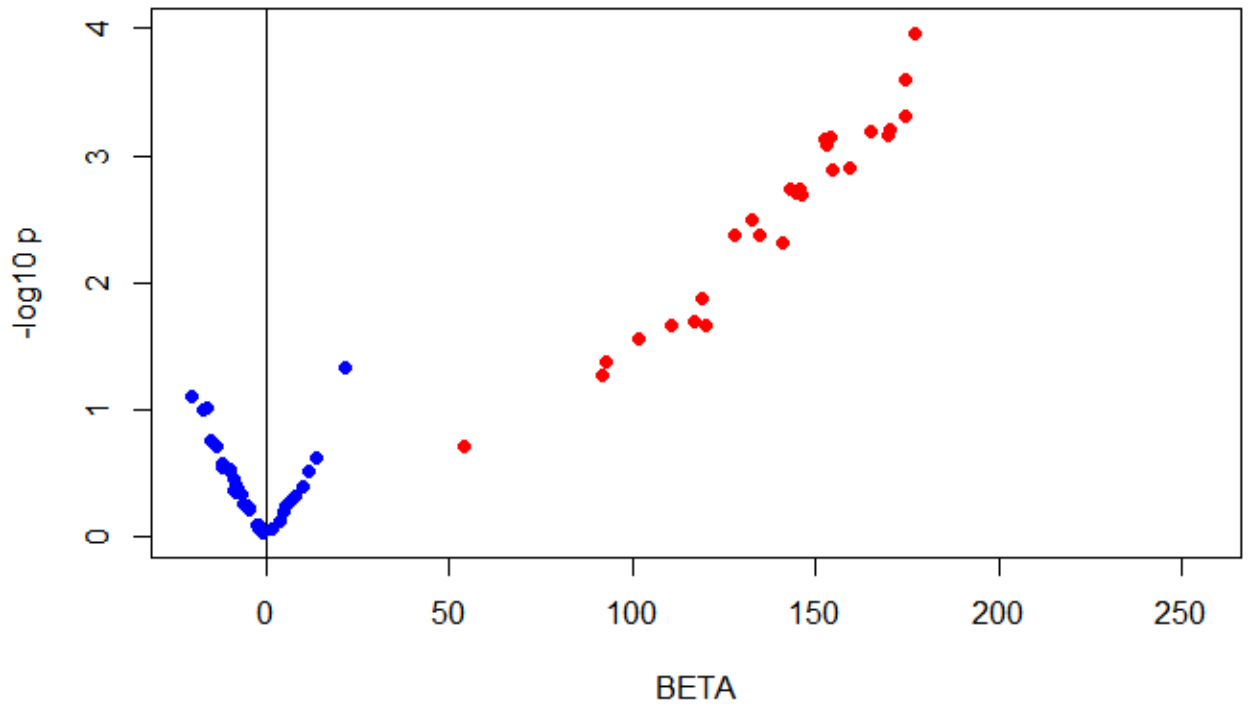



Observed log10 p
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
0.0
0.5
1.0
1.5
Expected log10 p

N = 100


-log10 p
0
1
2
3
4
0
50
100
150
200
250
BETA

N = 250



Comments

- Variability is only due to random sampling
  - Computer did the sampling
- As the sampled N → the full sample size (1000) the same individuals will be resampled
  - Studying the variability of the estimated "Statistics" can be informative
  - Bootstrap when N-sampled = full N

- Please go to
- https://bit.ly/HWSEQR to fill out the survey for this section