Advanced Data Analysis in Python

p-Values

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- The smaller the p-value, the less likely the data comes from the null distribution

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- Instead, produces $p(D|H_0)$
- $p(H_0|D) = \frac{p(H_0)}{p(D)} p(D|H_0)$

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- Therefore, $p(M|C) = \frac{p(M)}{p(C)} p(C|M) = 0.38$
- Probability of correctly classifying an individual as militia member given they are a member is 0.95, yet the probability that a person is a militia member given a positive classification is 0.38

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- As sample size increases we are able to distinguish smaller population-effect sizes progressively
- Interested in magnitude of effect; making binary decisions about the existence of an effect is not particularly informative

Further Issues

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- Asymmetry and accepting the null hypothesis: H_1 is held innocent until proven guilty, H_0 is held guilty until proven innocent

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- These errors waste research efforts and misinform policy decisions

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- Argued that the results stood in contrast to those from an earlier study with a statistically significant outcome

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- They also found a 95% confidence interval that spanned everything from a trifling risk decrease of 3% to a considerable risk increase of 48% ($p = 0.091$)
- The researchers from the earlier, statistically significant, study found the exact same risk ratio of 1.2
- That study was simply more precise, with an interval spanning from 9% to 33% greater risk ($p = 0.0003$)

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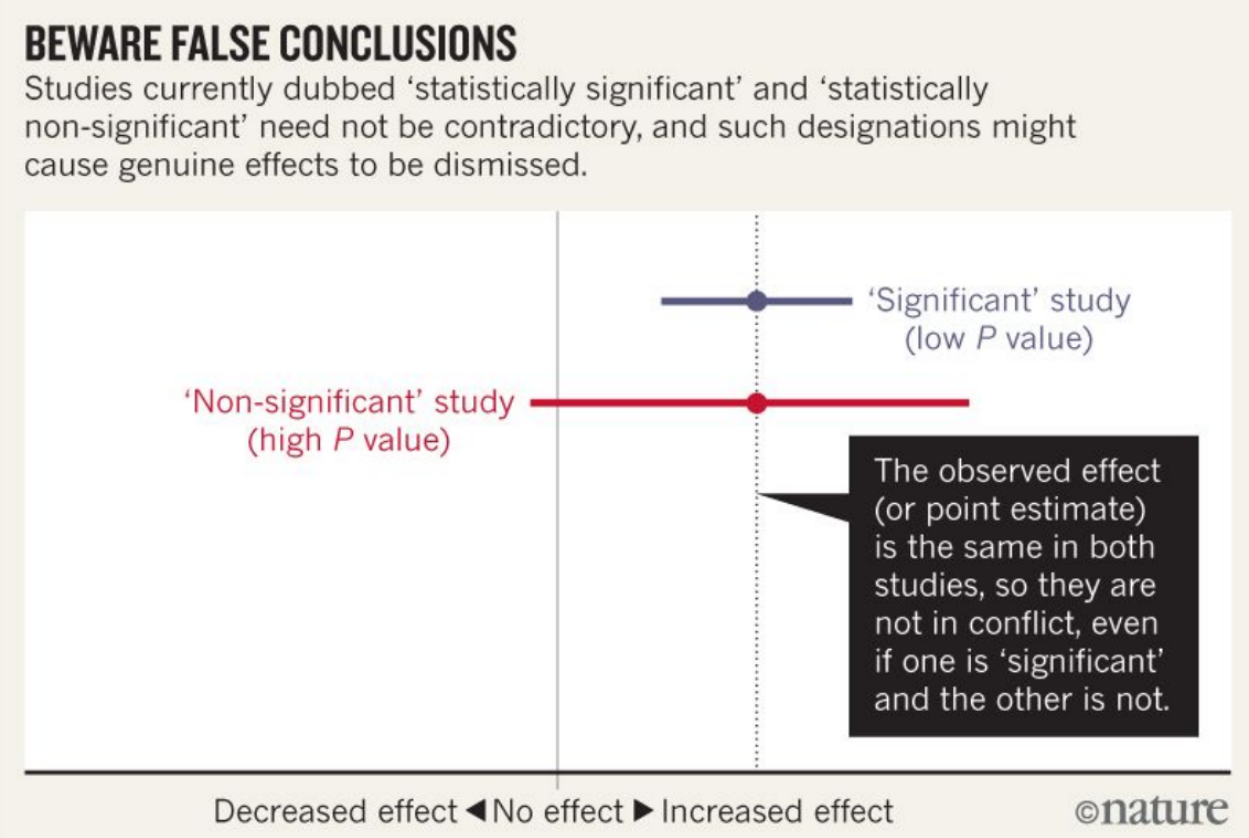
- Reliance on thresholds of statistical significance can mislead us

Example (cont.)



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- "Strangle-hold" (Rozenboom 1960)
- "Deeply flawed or else ill-used by researchers" (Serlin and Lapsley 1993)
- "A terrible mistake, basically unsound, poor scientific strategy, and one of the worst things that ever happened in the history of psychology" (Meehl 1978)

The Insignificance of Null Hypothesis Significance Testing (cont.)

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- "Systematically retarded the growth of cumulative knowledge" (Schmidt 1996)
- "The significance test as it is currently used in the social sciences just does not work" (Hunter 1997)

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- The authors call for the entire concept of statistical significance to be abandoned

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- One advocate called it a "surgical strike against thoughtless testing of statistical significance" and "an opportunity to register your voice in favour of better scientific practices"

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- Meta-analysis: Offers attractive proposition that the accumulation of knowledge on some research question can be compared and combined in a single procedure

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- Are there any alternatives not mentioned that you can think of?

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- Even results from pre-registered studies can be biased by decisions invariably left open in the analysis plan
- This occurs even with the best of intentions

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- Whether a p-value is small or large, caution is warranted

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- An interval that contains the null value will often also contain non-null values of high practical importance

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- It is thus wrong to claim that an interval shows all possible values

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- Interpreting the point estimate, while acknowledging its uncertainty, will keep you from making false declarations of 'no difference,' and from making overconfident claims

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- It is based on the false idea that there is a 95% chance that the computed interval itself contains the true value, coupled with the vague feeling that this is a basis for a confident decision
- Interval estimates can perpetuate the problems of statistical significance when the dichotomization they impose is treated as a scientific standard

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- Inferences should be scientific, and that goes far beyond the merely statistical
- Factors such as background evidence, study design, data quality and understanding of underlying mechanisms are often more important than statistical measures such as p-values or intervals