Statistical Inference

Contents

1 Inference

Definition 1.1 (Statistical inference)**.** Statistical inference is the process of analyzing data in order to learn about the shape and structure of a probability distribution. [1]

Statistical inference typically consists of two steps:

1. fitting a statistical model to data
2. summarizing our uncertainty about the parameters of the fitted model based on the data (and our prior beliefs).

There are two predominant paradigms for statistical inference:

1. Bayesian inference[2]
2. Frequentist inference[3]

2 Interpretation of Negative Findings

If an estimation interval includes the null hypothesis, or equivalently if a hypothesis test fails to reject the null hypothesis, that doesn't *necessarily* mean that the null hypothesis is true. Accordingly, we should not write interpretations of results as "the odds (or risks/hazards/means) are not significantly different"; instead, we should write something like "the data does not provide statistically significant EVIDENCE that the odds (or analogous estimands) differ". Statistical significance is a characteristic of evidence, not of the estimands.

P-values do not distinguish between absence of evidence and evidence of absence.

Confidence intervals do: if the confidence interval is narrow and includes the null value, then that confidence interval represents evidence of absence. If a confidence interval includes the null value but also includes substantially non-null values, then that confidence interval represents absence of evidence.

[1] I adapted this definition from Wikipedia's (Wikipedia contributors 2025).
[2] intro-bayes.qmd
[3] intro-MLEs.qmd#sec-intro-MLEs

Also, even if we do have statistically significant evidence of a non-null value, the estimated value may not be **substantially different from 0**, depending on what estimand is. For example, we might have statistically significant evidence that a certain exercise prolongs human lifespans by 20 seconds, but that effect would probably not be substantially different from 0 in practical terms.

Figure 1 sketches various scenarios for confidence intervals, from office hours. To do: convert this sketch into a nicely formatted figure.

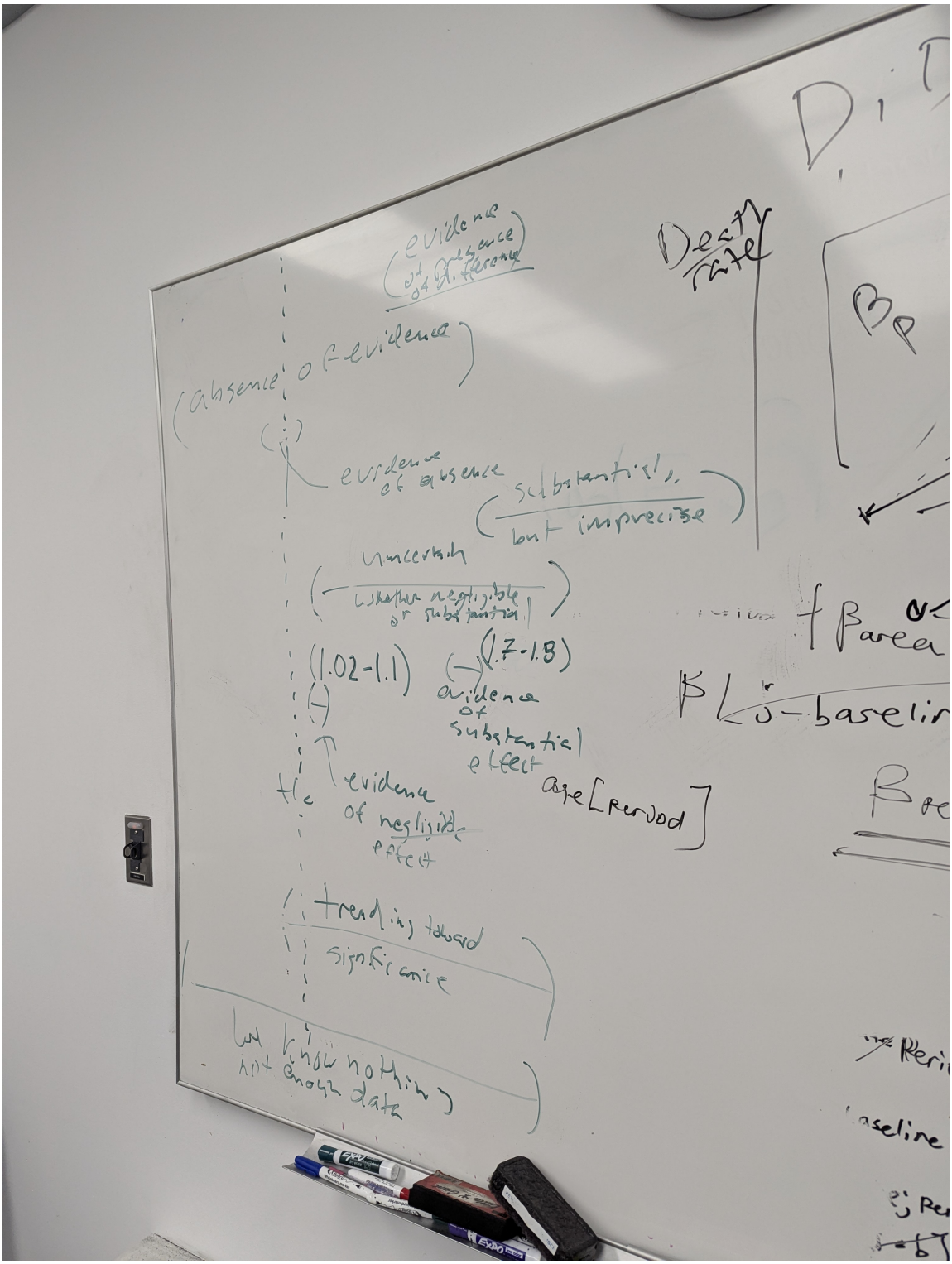

Figure 1: Interpretations of various confidence intervals

See also Vittinghoff et al. (2012) §3.7 (p64).

3 Confidence intervals

> **Definition 3.1** (margin of error)**.** The **margin of error** (a.k.a. the **radius**) is one-half the width of a confidence interval.

more:

- Anatomy of a confidence interval (text)[4]
- https://www.youtube.com/watch?v=vq1KrE7gU5M

References

Vittinghoff, Eric, David V Glidden, Stephen C Shiboski, and Charles E McCulloch. 2012. *Regression Methods in Biostatistics: Linear, Logistic, Survival, and Repeated Measures Models*. 2nd ed. Springer. https://doi.org/10.1007/978-1-4614-1353-0.

Wikipedia contributors. 2025. *Statistical Inference — Wikipedia, the Free Encyclopedia*. https://en.wikipedia.org/w/index.php?title=Statistical_inference&oldid=1304071803.

[4] https://wmed.edu/sites/default/files/ANATOMY%20OF%20A%20CONFIDENCE%20INTERVAL%20%28full%29.pdf