Statistical Rules of Thumb

(In progress)

Benzon Carlitos Salazar

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Introduction

These are just my notes on Dr. van Belle's book **Statistical Rules of Thumb**. You can find more information here, http://www.vanbelle.org/struts.htm.

The Basics

Distinguish Randomized and Observational Studies

This section discusses the common use of "convenience samples" in survey sampling, emphasizing their non-random nature. It acknowledges the criticism that such samples may not be representative of the population of interest. The response often involves attempting to justify the validity of making inferences from the sample, leaving the listener to evaluate the argument's validity rather than focusing solely on the sample itself.

Rule of Thumb Make a sharp distinction between observational and experimental studies.

What does it mean? It is important to clearly differentiate between two types of studies in research: observational studies and experimental studies.

Observational studies involve observing and analyzing phenomena as they naturally occur, without any manipulation or intervention by the researcher. In contrast, *experimental studies* involve manipulating variables to observe the effect on outcomes. The rule emphasizes the need to recognize and acknowledge the fundamental differences between these two types of studies to ensure accurate interpretation of research findings and appropriate application of methodologies.

Beware of Linear Models

Statisticians are experts in fitting statistical models to data, particularly linear models and their generalizations. It underscores a cautionary observation by March (1996), stating that deriving an empirical formula without underlying theoretical support does not significantly contribute to advancing understanding.

Rule of Thumb Always look for a physical model underlying the data being analyzed. Assume that a statistical model such as a linear model is a good first start only.

What does it mean? Researchers or analysts should seek a physical or theoretical model that underlies the data being examined. This rule suggests that while statistical models, such as linear models, can be useful as a starting point, one should not solely rely on them. Instead, it emphasizes the importance of understanding the underlying mechanisms or principles that govern the data. By incorporating a physical model, the analysis may be more robust, accurate, and reflective of the real-world processes that generate the data. Essentially, it encourages a thoughtful consideration of the context and a broader exploration beyond statistical models alone.

Understand Omnibus Quantities

Data reduction is a crucial task for statisticians, involving two main types. The first type includes calculating statistics, like sample mean, to estimate parameters in populations. The second type involves model reduction, such as standardized differences between populations, which reduces the number of parameters. Examples include p-values, Mahalanobis distances, and F-tests, collectively referred to as *omnibus quantities*.

Rule of Thumb Be sure to understand the components and purpose of an omnibus quantity.

What does it mean? The rule of thumb advises individuals to thoroughly comprehend the elements and objectives of an omnibus quantity. An omnibus quantity refers to a composite statistic or parameter that captures multiple aspects of a statistical analysis. To follow this rule, one should not only be aware of the components that contribute to the omnibus quantity but also understand why it is used and what information or insights it provides in the context of the analysis. This understanding is essential for proper interpretation and informed decision-making in statistical analyses.

Assess Independence, Equal Variance, and Normality - In That Order

Classical hypothesis tests typically require assumptions about the distributions from which data were sampled. The primary distinction between parametric and nonparametric tests lies in the assumption of a normal distribution. Apart from this, the remaining assumptions for parametric tests also apply to their nonparametric counterparts.

Rule of Thumb Classical hypothesis test assume that the observations (1) are independent, (2) all come from populations with the same variance, and for parametric tests, (3) follow a normal distribution. The most important (in terms of maintaining an assumed Type I error level: the probability of rejecting the null hypothesis when it is true) are the first, then the second, then the third.

What does it mean? The rule emphasizes that classical hypothesis tests make key assumptions about the data. Independence of observations is the most critical, followed by homogeneity of variances, and then, for parametric tests, adherence to a normal distribution. Maintaining these assumptions is crucial for controlling the risk of Type I errors in hypothesis testing.

Keep Models As Simple As Possible, But Not More Simple

This section underscores the critical role of selecting an appropriate statistical model in the processes of data analysis and reduction. Ockham's razor guides the model selection process by advocating a preference for the simplest model when multiple models are equally effective in explaining the data. This principle is rooted in the idea that simpler explanations are generally more preferable, providing a practical guideline for researchers and analysts in navigating the complexities of model selection during data analysis.

Rule of Thumb One formal statement of Ockham's razor is: "Do no multiply hypotheses beyond necessity."

What does it mean? The rule essentially means that when faced with multiple competing explanations or models that can account for a set of observations or data, one should prefer the simplest or most straightforward explanation that adequately explains the phenomena. In other words, avoid introducing unnecessary complexities or additional assumptions unless they are absolutely required to account for the observed facts.

This principle suggests a preference for simplicity and parsimony in scientific explanations. It implies that, all else being equal, a simpler explanation is more likely to be correct or at least more useful until evidence suggests otherwise. Ockham's razor is a heuristic or rule of thumb that guides scientists and researchers in making decisions about the selection of models or theories when faced with various options.

Reference

- Belle, G. V. (2002). Statistical rules of thumb. Wiley.