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Thesis abstract

Robust statistical inference for one-shot devices based on divergences

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The reliability of a product, system, weapon, or piece of equipment can be defined as the ability of the device to perform as designed for, or, more simply, as the probability that the device does not fail when used. Engineers assess reliability by repeatedly testing the device and observing its failure rate. Certain products, called "one-shot" devices, make this approach challenging. For this kind of device, one can only know whether the failure time is either before or after a specific inspection time, and consequently the lifetimes are either left- or right-censored, with the lifetime being less than the inspection time if the test outcome is a failure (resulting in left-censoring) and the lifetime being more than the inspection time if the test outcome is a success (resulting in right-censoring). An accelerated life test (ALT) plan is usually employed to evaluate the reliability of such products by increasing the levels of stress factors and then extrapolating the life characteristics from high stress conditions to normal operating conditions. This acceleration process will shorten the life span of devices and reduce the costs associated with the experiment. The study of one-shot devices from ALT data has been developed considerably recently.

On the other hand, in the last decades the use of divergence measures in the resolution of statistical problems has reached a remarkable relevance in the areas of parametric estimation and parametric tests of hypotheses, together with many non-parametric uses. Particularly, the family of density power divergences is known for its robustness.

Most of the results concerning one-shot devices are based on maximum likelihood estimation (MLE), which is well-known to be efficient, but also non-robust. Therefore, testing procedures based on MLE face serious robustness problems. Along this thesis, robust estimators and tests are developed based on density power divergences for one-shot device testing.

The thesis proceeds as follows. In Chapter 2, we assume the one-shot devices with lifetimes having exponential distribution with a single-stress relationship. In Chapter 3, the exponential distribution with multiple-stress relationship is considered, generalizing the results in Chapter 2. Next, in Chapter 4 and Chapter 5, we consider the situation when lifetimes follow, respectively, a Gamma and a Weibull distribution with non-constant shape parameters. In Chapter 6, similar procedures are applied to other distribution functions, such as Lindley and lognormal. Chapter 7 develop robust inference for one-shot device testing under the proportional hazards assumption and, in

Chapter 8, we consider the competing risk model (assuming different possible causes of failure) with exponential lifetimes. Chapter 9 summarizes the main results of previous chapters and gives some ideas about future work. Appendices A and B briefly present some other results, which have also been obtained by the candidate during her Ph.D. studies.

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