# Imprecise Statistical Methods for Accelerated Life Testing

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**Abstract**

Accelerated Life Testing (ALT) is frequently used to obtain information on the lifespan of devices. Testing items under normal conditions can require a great deal of time and expense. To determine the reliability of devices in a shorter period of time, and with lower costs, ALT can often be used. In ALT, a unit is tested under levels of physical stress (e.g. temperature, voltage, or pressure) greater than the unit will experience under normal operating conditions. Using this method, units tend to fail more quickly, requiring statistical inference about the lifetime of the units under normal conditions via extrapolation based on an ALT model.

This thesis presents a novel method for statistical inference based on ALT data. The method quantifies uncertainty using imprecise probabilities, in particular it uses Nonparametric Predictive Inference (NPI) at the normal stress level, combining data from tests at that level with data from higher stress levels which have been transformed to the normal stress level. This has been achieved by assuming an ALT model, with the relation between different stress levels modelled by a simple parametric link function. We derive an interval for the parameter of this link function, based on the application of classical hypothesis tests and the idea that, if data from a higher stress level are transformed to the normal stress level, then these transformed data and the original data from the normal stress level should not be distinguishable. In this thesis we consider two scenarios of the methods. First, we present this approach with the assumption of Weibull failure time distributions at each stress level using the likelihood ratio test to obtain the interval for the parameter of the link function. Secondly, we present this method without an assumed parametric distribution at each stress level, and using a nonparametric hypothesis test to obtain the interval.

To illustrate the possible use of our new statistical method for ALT data, we present an application to support decisions on warranties. A warranty is a contractual commitment between consumer and producer, in which the latter provides post-sale services in case of product failure. We will consider pricing basic warranty contracts based on the information from ALT data and the use of our novel imprecise probabilistic statistical method.