AN OVERVIEW OF WEIBULL ANALYSIS pdf

1: Biography Of Dr. Robert B. Abernethy, World Class Weibull Expert

Probability Distributions > Weibull Distribution and Analysis. Contents: What is the Weibull distribution? Weibull PDFs; The Weibull family; Weibull Analysis; What is the Weibull Distribution? The Weibull distribution is a continuous probability distribution named after Swedish mathematician Waloddi Weibull.

The correlation coefficient is: Note that the slight variation in the results is due to the number of significant figures used in the estimation of the median ranks. The goal in this case is to fit a curve, instead of a line, through the data points using nonlinear regression. The Gauss-Newton method can be used to solve for the parameters, , and , by performing a Taylor series expansion on. Then the nonlinear model is approximated with linear terms and ordinary least squares are employed to estimate the parameters. This procedure is iterated until a satisfactory solution is reached. Note that other shapes, particularly S shapes, might suggest the existence of more than one population. In these cases, the multiple population mixed Weibull distribution , may be more appropriate. The results and the associated graph for the previous example using the 3-parameter Weibull case are shown next: Maximum Likelihood Estimation As outlined in Parameter Estimation , maximum likelihood estimation works by developing a likelihood function based on the available data and finding the values of the parameter estimates that maximize the likelihood function. This can be achieved by using iterative methods to determine the parameter estimate values that maximize the likelihood function, but this can be rather difficult and time-consuming, particularly when dealing with the three-parameter distribution. Another method of finding the parameter estimates involves taking the partial derivatives of the likelihood function with respect to the parameters, setting the resulting equations equal to zero and solving simultaneously to determine the values of the parameter estimates. The log-likelihood functions and associated partial derivatives used to determine maximum likelihood estimates for the Weibull distribution are covered in Appendix D. Solution In this case, we have non-grouped data with no suspensions or intervals, i. The equations for the partial derivatives of the log-likelihood function are derived in an appendix and given next: Solving the above equations simultaneously we get: Note that the decimal accuracy displayed and used is based on your individual Application Setup. The biasness will affect the accuracy of reliability prediction, especially when the number of failures are small. When there are no right censored observations in the data, the following equation provided by Hirose [39] is used to calculated the unbiased. When there are right censored observations in the data, the following equation provided by Ross [40] is used to calculated the unbiased. The software will use the above equations only when there are more than two failures in the data set. For an example on how you might correct biased estimates, see also: The complete derivations were presented in detail for a general function in Confidence Bounds. Bounds on the Parameters One of the properties of maximum likelihood estimators is that they are asymptotically normal, meaning that for large samples they are normally distributed. Additionally, since both the shape parameter estimate, , and the scale parameter estimate, must be positive, thus and are treated as being normally distributed as well. The lower and upper bounds on the parameters are estimated from Nelson [30]:

2: The Weibull Distribution - ReliaWiki

AN OVERVIEW OF WEIBULL ANALYSIS Objective This handbook will provide an understanding of life data analysis. Weibull and Log Normal analysis.

File may be more up-to-date Reliability Life Data Analysis refers to the study and modeling of observed product lives. Life data can be lifetimes of products in the marketplace, such as the time the product operated successfully or the time the product operated before it failed. These lifetimes can be measured in hours, miles, cycles-to-failure, stress cycles or any other metric with which the life or exposure of a product can be measured. All such data of product lifetimes can be encompassed in the term life data or, more specifically, product life data. The subsequent analysis and prediction are described as life data analysis. For the purpose of this reference, we will limit our examples and discussions to lifetimes of inanimate objects, such as equipment, components and systems as they apply to reliability engineering, however the same concepts can be applied in other areas. An Overview of Basic Concepts When performing life data analysis also commonly referred to as Weibull analysis , the practitioner attempts to make predictions about the life of all products in the population by fitting a statistical distribution model to life data from a representative sample of units. The parameterized distribution for the data set can then be used to estimate important life characteristics of the product such as reliability or probability of failure at a specific time, the mean life and the failure rate. Life data analysis requires the practitioner to: Gather life data for the product. Select a lifetime distribution that will fit the data and model the life of the product. Estimate the parameters that will fit the distribution to the data. Generate plots and results that estimate the life characteristics of the product, such as the reliability or mean life. Lifetime Distributions Life Data Models Statistical distributions have been formulated by statisticians, mathematicians and engineers to mathematically model or represent certain behavior. The probability density function pdf is a mathematical function that describes the distribution. The pdf can be represented mathematically or on a plot where the x-axis represents time, as shown next. The 3-parameter Weibull pdf is given by: The Weibull model can be applied in a variety of forms including 1-parameter, 2-parameter, 3-parameter or mixed Weibull. Other commonly used life distributions include the exponential, lognormal and normal distributions. The analyst chooses the life distribution that is most appropriate to model each particular data set based on past experience and goodness-of-fit tests. Parameter Estimation In order to fit a statistical model to a life data set, the analyst estimates the parameters of the life distribution that will make the function most closely fit the data. The parameters control the scale, shape and location of the pdf function. For example, in the 3-parameter Weibull model shown above , the scale parameter, , defines where the bulk of the distribution lies. The shape parameter, , defines the shape of the distribution and the location parameter, , defines the location of the distribution in time. Several methods have been devised to estimate the parameters that will fit a lifetime distribution to a particular data set. The appropriate analysis method will vary depending on the data set and, in some cases, on the life distribution selected. Calculated Results and Plots Once you have calculated the parameters to fit a life distribution to a particular data set, you can obtain a variety of plots and calculated results from the analysis, including: The probability that a unit will operate successfully at a particular point in time. Probability of Failure Given Time: The probability that a unit will be failed at a particular point in time. Probability of failure is also known as "unreliability" and it is the reciprocal of the reliability. The average time that the units in the population are expected to operate before failure. The number of failures per unit time that can be expected to occur for the product. The estimated time when the reliability will be equal to a specified goal. A plot of the probability of failure over time. Note that probability plots are based on the linearization of a specific distribution. Consequently, the form of a probability plot for one distribution will be different than the form for another. For example, an exponential distribution probability plot has different axes than those of a normal distribution probability plot. A plot of the reliability over time. A plot of the probability density function pdf. A plot of the failure rate over time. A graphical representation of the possible solutions to the likelihood ratio equation. This is employed to make comparisons between two different data sets. Confidence Bounds Because life data analysis results are estimates based on the observed lifetimes of a sampling of units, there is uncertainty in the results due to the limited sample sizes. Whether or not a specific interval contains the quantity of interest is unknown. Confidence bounds can be expressed as two-sided or one-sided. Two-sided bounds are used to indicate that the quantity of interest is contained within the bounds with a specific confidence. One-sided bounds are used to indicate that the quantity of interest is above the lower bound or below the upper bound with a specific confidence. The appropriate type of bounds depends on the application. For example, the analyst would use a one-sided lower bound on reliability, a one-sided upper bound for percent failing under warranty and two-sided bounds on the parameters of the distribution. Note that one-sided and two-sided bounds are related. Reliability Engineering Since the beginning of history, humanity has attempted to predict the future. Watching the flight of birds, the movement of the leaves on the trees and other methods were some of the practices used. Through the use of life data analysis, reliability engineers use product life data to determine the probability and capability of parts, components, and systems to perform their required functions for desired periods of time without failure, in specified environments. For the purpose of this reference, we will limit our examples and discussions to lifetimes of inanimate objects, such as equipment, components and systems as they apply to reliability engineering. Before performing life data analysis, the failure mode and the life units hours, cycles, miles, etc. Further, it is quite necessary to define exactly what constitutes a failure. In other words, before performing the analysis it must be clear when the product is considered to have actually failed. This may seem rather obvious, but it is not uncommon for problems with failure definitions or time unit discrepancies to completely invalidate the results of expensive and time consuming life testing and analysis. Estimation In life data analysis and reliability engineering, the output of the analysis is always an estimate. The true value of the probability of failure, the probability of success or reliability , the mean life, the parameters of a distribution or any other applicable parameter is never known, and will almost certainly remain unknown to us for all practical purposes. Granted, once a product is no longer manufactured and all units that were ever produced have failed and all of that data has been collected and analyzed, one could claim to have learned the true value of the reliability of the product. Obviously, this is not a common occurrence. The objective of reliability engineering and life data analysis is to accurately estimate these true values. One method is to pick out a small sample of marbles and count the black ones. Suppose we picked out ten marbles and counted four black marbles. If we now repeat the experiment and pick out 1, marbles, we might get results for the number of black marbles such as and black marbles for each trial. In this case, we note that our estimate for the percentage of black marbles has a narrower range, or Using this, we can see that the larger the sample size, the narrower the estimate range and, presumably, the closer the estimate range is to the true value. A Brief Introduction to Reliability A Formal Definition Reliability engineering provides the theoretical and practical tools whereby the probability and capability of parts, components, equipment, products and systems to perform their required functions for desired periods of time without failure, in specified environments and with a desired confidence, can be specified, designed in, predicted, tested and demonstrated, as discussed in Kececioglu [19]. Reliability Engineering and Business Plans Reliability engineering assessment is based on the results of testing from in-house or contracted labs and data pertaining to the performance results of the product in the field. The data produced by these sources are utilized to accurately measure and improve the reliability of the products being produced. This is particularly important as market concerns drive a constant push for cost reduction. However, one must be able to keep a perspective on the big picture instead of merely looking for the quick fix. It is often the temptation to cut corners and save initial costs by using cheaper parts or cutting testing programs. Unfortunately, cheaper parts are usually less reliable and inadequate testing programs can allow products with undiscovered flaws to get out into the field. A quick savings in the short term by the use of cheaper components or small test sample sizes will usually result in higher long-term costs in the form of warranty costs or loss of customer confidence. The proper balance must be struck between reliability, customer satisfaction, time to market, sales and features. The figure below illustrates this concept. The polygon on the left represents a properly balanced project. The polygon on the right represents a project in which reliability and customer satisfaction have been sacrificed for the sake of sales and time to market. Our growing dependence on technology requires that the products that make up our daily lives successfully work for the desired or designed-in period of time. It is not sufficient that a product works for time shorter than its mission duration, but at the same time there is no need to design a product to operate much past its intended life, since this would impose additional costs on the manufacturer. Reliability engineering was born out of the necessity to avoid such catastrophic events and, with them, the unnecessary loss of life and property. Today, reliability engineering can and should be applied to many products. The previous example of the failed remote control does not have any major life and death consequences to the consumer. However, it may pose a life and death risk to a non-biological entity: The modern consumer will no longer tolerate products that do not perform in a reliable fashion, or as promised or advertised. Statistics show that when a customer is satisfied with a product he might tell eight other people; however, a dissatisfied customer will tell 22 people, on average. The critical applications with which many modern products are entrusted make their reliability a factor of paramount importance. For example, the failure of a computer component will have more negative consequences today than it did twenty years ago. This is because twenty years ago the technology was relatively new and not very widespread, and one most likely had backup paper copies somewhere. Now, as computers are often the sole medium in which many clerical and computational functions are performed, the failure of a computer component will have a much greater effect. Reliability Maintainability Availability All three of these areas can be numerically quantified with the use of reliability engineering principles and life data analysis. And the combination of these three areas introduces a new term, as defined in ISO, "Dependability. Do note, however, that this figure is somewhat idealized. This curve is plotted with the product life on the x-axis and with the failure rate on the y-axis. The life can be in minutes, hours, years, cycles, actuations or any other quantifiable unit of time or use. The failure rate is given as failures among surviving units per time unit.

3: Reliability Publications Subject Index for ReliaSoft's Reliability Edge and HotWire

Chapter 1: An Overview of Weibull Analysis Dr. Robert B. Abernethy â€¢ Oyster Road, North Palm Beach, FL â€¢ CHAPTER 1. AN OVERVIEW OF WEIBULL ANALYSIS Objective This handbook will provide an understanding of standard and advanced Weibull and Log Normal techniques originally developed for failure analysis.

4: Introduction to Life Data Analysis - ReliaWiki

Life Data Analysis (Weibull Analysis) An Overview of Basic Concepts. In life data analysis (also called "Weibull analysis"), the practitioner attempts to make predictions about the life of all products in the population by fitting a statistical distribution to life data from a representative sample of units.

5: Weibull Analysis 3-Day Course â€“ Quanterion Solutions Incorporated

an overview of weibull analysis The following are examples of engineering problems solved with Weibull analysis: â€¢ A project Solutions are possible at the earliest indications of a problem.

6: CHAPTER AN OVERVIEW OF WEIBULL ANALYSIS - PDF documents

The Weibull distribution is a generalization of the exponential. In the exponential, the hazard rate (i.e., the instantaneous event rate) is constant over time, whereas the Weibull allows the hazard to vary over time, leading to an "accelerated failure time" survival model if the hazard increases over time.

7: Weibull distribution - Wikipedia

Summary. For non-repairable data, a Weibull analysis is a great way to visualize and understand the time to failure data you likely already have available.

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8: Weibull and Life Data Analysis - HBM Prenscia

Weibull Distribution The Weibull distribution is a special case out of a more general class of distribution functions for flaws whose size frequency distribution decreases with increasing flaw size corresponding to a power law (Eqn (35)).

9: Weibull Analysis - ReliaSoft

analysis is very suitable for such reliability data, especially Weibull model is a well established tool to fit the test data and to predict the future failure trend.

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