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THE SEVEN HANDIEST CONFIDENCE FORMULAS IN ENGINEERING STATISTICS

INTRODUCTION

In dealing with statistical problems of engineering testing programs there are certain types of problem situations most frequently encountered. These situations are listed below :

SITUATION # 1 : Significance Problems at the Bq Level with respect to a Fixed Target.

SITUATION # 2 : Significance Problems of Comparison at the Bq Level .

SITUATION # 3 : Significance Problems concerning Weibull Slopes .

SITUATION # 4 : Significance Problems concerning Entropy .

In this bulletin we shall present what we call the Seven Handiest Confidence Formulas in Engineering Statistics involving the above situations.

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FORMULAS FOR SITUATION # 1
(B_Q Life Questions)

FORMULA I : If the Observed B_Q Life on a Weibull plot of slope b and sample size N is denoted by ${}_{.50}B_Q$ (using Median Ranks). then the Confidence that the actual population B_Q Life will be at least x is given by the formula

$$C = \frac{1}{1 + \left(\dfrac{x}{{}_{.50}B_Q} \right)^{\frac{b\sqrt{N}}{.55}}}$$

(PARAMETRIC FORMULA)

FORMULA II : The Non-Parametric relation between Confidence and ${}_{C}B_Q$ Life when the Observed Characteristic Life from a Weibull plot of slope b and sample size N is θ :

$${}_{C}B_Q = \theta \left[\ln \frac{1}{1 - Z_{1-C}(j, N)} \right]^{\frac{1}{b}}$$

Where C = Confidence

$Z_{1-C}(j, N)$ = (1 - C) Rank of j^{th} order statistic in N
where j = .3 + Q (N + .4)

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FORMULAS FOR SITUATION # 2

(B_Q LIFE COMPARISON PROBLEMS)

$(0 \leq Q \leq .5)$

FORMULA III : If two samples being compared at Quantile Q posses T Degrees of Freedom and if each sample has Weibull slope b and if the Ratio of B_Q Lives is ϱ = (Larger B_Q/Smaller B_Q), then the Confidence of a Real Difference in B_Q Lives is

$$C = \frac{1}{1 + \varrho^{-bT^{\frac{1}{4}}\sqrt{2Q}}}$$

(NON-PARAMETRIC FORMULA)

FORMULA IV : The PARAMETRIC FORMULA for the same situation is

$$C = \frac{1}{1 + \varrho^{-bT^{\frac{1}{4}}}}$$

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FORMULAS FOR SITUATION # 3
(WEIBULL SLOPE QUESTIONS)

FORMULA V : If a Weibull plot from a sample of size N yields an Observed Weibull Slope $b_{obs.} > b_{std.}$, then the Confidence that the population Weibull slope is really greater than $b_{std.}$ is

$$C = \frac{1}{1 + e^{-\frac{\sqrt{2N}}{.55}\left[1 - \left(\frac{b_{std.}}{b_{obs.}}\right)\right]}}$$

FORMULA VI : If sample #1 has size N_1 and Weibull slope b_1 and if sample #2 has size N_2 and Weibull slope b_2 , then the Confidence of a Real Difference in Weibull slopes is (Assuming $b_2 > b_1$)

$$C = \frac{1}{1 + e^{\left[\frac{-1.8138\, k\,(b_2 - b_1)}{\frac{b_1}{\sqrt{2N_1}} + \frac{b_2}{\sqrt{2N_2}}}\right]}}$$

Where
$$k = \sqrt{1 + \frac{\sqrt{N_1 N_2}}{\frac{1}{2}(N_1 + N_2)}}$$

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A FORMULA FOR SITUATION # 4

(CONFIDENCE OF STAYING ABOVE A LOWER SPEC IN LIFE TEST DATA ANALYSIS VIA ENTROPY)

FORMULA VII : If the lower spec. (Goal) for durability life is the CDF $F(x) = 1 - e^{-\mathcal{E}(x)}$ $\left(\mathcal{E}(x) \equiv \text{ENTROPY at } x\right)$, and if a life test data set consists of times to failure $x_1, x_2, x_3, \cdots x_N$ out of which r actually failed ($r \geq 1$) , then the Confidence of beating the goal $F(x)$ for the life distribution is

$$C = \frac{1}{1 + e^{-\frac{\sqrt{r}\left(\mathcal{E}_{ave} - 1\right)}{.55}}}$$

Where

$$\mathcal{E}_{ave.} = \frac{\mathcal{E}(x_1) + \mathcal{E}(x_2) + \mathcal{E}(x_3) + \cdots + \mathcal{E}(x_N)}{r}$$

i. e.,

$\mathcal{E}_{ave.}$ = AVERAGE ENTROPY PER FAILURE