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ACCEPTANCE SAMPLING BASED ON LIFE TESTS: PARETO-RAYLEIGH MODEL

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ABSTRACT

Alzaatreh, et al. (2012) proposed a new family of distributions called Transformed-Transformer family (or T-X family). In this paper a new combination of T-X family is proposed. Two standard probability models Pareto and Rayleigh are used to define a new T-X family called Pareto – Rayleigh model and is considered as a Life – testing model. The problem of acceptance sampling when the life test is truncated at a pre-assigned time is discussed with known shape parameters. For various acceptance numbers, confidence levels and values of the ratio of the fixed experimental time to the specified mean life, the minimum sample size necessary to assure a specified mean life time worked out. The operating characteristic functions of the sampling plans and producer's risk are derived. The ratio of true mean life to a specified mean life that ensures acceptance with a pre-assigned probability are tabulated. The results are presented by an example.

Key Words: T-X family, Pareto - Rayleigh model, Operating Characteristic function, Sampling plans, truncated life tests.

I INTRODUCTION

Let $F(x)$ be the cumulative distribution function (CDF) of any random variable X and $r(t)$ be the probability density function (PDF)of a random variable, T, defined on $[0,\infty)$. The CDF of the T-X family of distributions defined by Alzaatreh, *et al*. [1] (2012) is given by

$$G(x) = \int_0^{-\log[1-F(x)]} r(t)dt \tag{1}$$

Alzaatreh, et al. [1] (2012) named this family of distributions as the Transformed-Transformer family (or T-X family). If a random variable T follows the Pareto distribution type IV with parameter α then

$$r(t,\alpha,\sigma) = \frac{\alpha}{\sigma}\left[1+\frac{t}{\sigma}\right]^{-(\alpha+1)}$$

$$= \alpha\left[1+t\right]^{-(\alpha+1)}; \quad t>0, \alpha>1, \sigma=1 \tag{2}$$

If a random variable X follows the Rayleigh distribution with parameter σ then

$$F(x)=1-e^{-x^2/2\sigma^2}; \qquad x>0, \sigma>0 \tag{3}$$

Using (1), (2) and (3), we obtain a new T-X family of distribution called Pareto-Rayleigh distribution (P-R distribution) and its CDF is given by

$$G(x)=1-\left[1+\frac{x^2}{2\sigma^2}\right]^{-\alpha}; \quad x>0, \alpha>1, \sigma>0 \tag{4}$$

The probability density function (pdf) corresponding to (4) is

$$g(x)=\frac{\alpha}{\sigma^2}x\left[1+\frac{x^2}{2\sigma^2}\right]^{-\alpha-1}; \quad x>0, \alpha>1, \sigma>0 \tag{5}$$

where α is shape parameter and σ is scale parameter.

Acceptance sampling is considered with inspection and decision making regarding lots of product and constitutes one of the oldest techniques in quality assurance. A typical application of acceptance sampling is as follows: a company receives a shipment of product from a vendor. This product is often a component or raw material used in the company's manufacturing process. A sample is taken from the lot, the relevant quality characteristic of the units in the sample is inspected. On the basis of the information in this sample, a decision is made regarding lot disposition. Usually, this decision is either to accept or to reject the lot. Some times we refer to this decision as lot sentencing. Accepted lots are put into production, while rejected lots may be returned to the vendor or may be subjected to some other lot disposition action. While it is customary to think of acceptance sampling as receiving inspection activity, there are also other uses. For example, frequently a manufacturer samples and inspects its own product at various stages of production. Lots that are accepted are sent forward for further processing, while rejected lots may be reworked or scrapped.

The purpose of acceptance sampling is to sentence lots, but not to determine lot quality for example by an estimation procedure. Thus, most acceptance sampling plans are not designed and, hence, are not appropriate for estimation purposes. This is a surprising and somewhat alarming fact, because deciding on a lot without knowing its quality seems to be rather hazardous. Therefore, we will develop a procedure for determining the value of the relevant quality characteristic in order to make the required decision. '

A sampling inspected plans in the case that the sample observations are lifetimes of products put on test aims at verifying that the actual population average exceeds a required minimum. The population average stands for the average lifetime of the product, say, μ. If μ_0 is a specified minimum value then one would like to verify that $\mu \geq \mu_0$, this means that the true unknown population average lifetime of the product exceeds the specified value. On the basis of a random sample of size *n*, the lot is accepted if $\mu \geq \mu_0$. Otherwise the lot is rejected. If the observed number of failure is large, say larger than a number *c*, the derived lower bound is smaller than μ_0 and the hypothesis $\mu \geq \mu_0$ is not verified. Hence, the lot cannot be accepted. Such a sampling plan is named *reliability test plan* or *acceptance sampling plans* based on life tests.

Such a procedure obviously requires the specification of the probability model governing the life of the products. Exponential distribution-the CFR model is the central distribution in reliability studies. Epstein [2] (1954) developed reliability test plans for exponential distribution. Sobel and Tischendrof [3] (1959) proposed acceptance sampling with new life test objectives. Sobel Gupta and Groll [4] (1961) constructed sampling plans similar to those of Epstein [2] (1954) based on Gamma distribution. Sampling plans similar to those of Gupta and Groll [4] (1961) are developed by Kantam and Rosaiah [5] (1998) for half-logistic distribution and Kantam *et al.* [6] (2001) for log-logistic distribution, Rosaiah and Kantam [7] (2005) for the inverse Rayleigh distribution, Srinivasa Rao *et al.* [8] (2009) for Marshall-Olkin extended Lomax distribution, Rosaiah *et al*. [9] (2009) for Pareto distribution, Subba Rao *et al*. [10] (2013) developed acceptance sampling on Life Tests: Exponentiated Pareto Model and Subba Rao *et al*. [11] (2014) for Size Biased Lomax Model. Some related works on Pareto and Pareto-Rayleigh model are studied by Subba Rao *et al*. [12] (2013) percentiles of Range – Pareto Type model, Subba Rao *et. al*. [13] (2015) modified maximum likelihood estimation and Prasad and Kantam [14] (2015) studied a test procedure to discriminate between probability models.

In the present paper it is assumed that the probability distribution of a life time random variable is Pareto-Rayleigh distribution with known shape parameters. The problem considered is that of finding the minimum sample size necessary to assure a certain average life when the life test is terminated at a pre-assigned time *t* and when the observed number of failures does not exceed a given acceptance number. The decision procedure is to accept a lot only if the specified average life can be established with a pre-assigned high probability *p**, which provides the protection to the consumer. The decision to accept the lot can take place only at the end of time *t* and only if the number of failures does not exceed the given acceptance number *c*. The life test experiment gets terminated at the time at which $(c+1)^{th}$ failure is observed or at the end of time *t* whichever is earlier. In the first case the decision is to reject the lot.

In section 2, we have obtained the minimum sample sizes necessary for various acceptance numbers - *c*, for various confidence levels - *p** and various ratios of the test time-*t* to the specified average life σ_0 using cumulative Binomial probabilities and cumulative Poisson probabilities for Pareto-Rayleigh distribution with known shape parameters (α = 2, 3, 4, σ = 1). Section 3 deals with the operating characteristic and producer's risk of the sampling plans. The results are observed for α = 2, 3, 4, σ = 1 and presented for α = 2, σ = 1 due to the space constraints. The use of the numerical tables is described through an illustration in Section 4 and the results are explained by an example in Section 5.

II RELIABILITY TEST PLAN

A common practice in life testing is to terminate a life test by a predetermined time t and observe the number of failures (assuming that a failure is well-defined). One of the objectives of these experiments is to set a lower confidence limit on the average life. It is then desired to establish a specified average life with a given probability of at least p^*. The decision to accept the specified average life occurs if and only if the number of observed failures at the end of the fixed time t does not exceed a given number c – called the acceptance number. The test may get terminated before the time t is reached when the number of failures exceeds c – the decision then being to reject the specified average life. For such a truncated life test and the associated decision rule, we are interested in obtaining the smallest sample size necessary to achieve the objective.

A sampling plan consists of

- the number of units n on test,
- an acceptance number c such that if c or fewer failures occur during the test time t, the lot is accepted and
- a ratio t/σ_0 where σ_0 is the specified average life.

We fix the consumer's risk the probability of accepting a bad lot (the one for which the true average life is below the specified life p_0) not to exceed $1-p^*$, so that p^* is a minimum confidence level with which a lot of true average life below σ_0 is rejected by the sampling plan. For a fixed p^* our sampling plan is characterized by $(n,c,t/\sigma_0)$. Here we considered a lot of infinitely large size. Mathematically, given a number p^* $(0<p^*<1)$, a value σ_0 of σ and an acceptance number c, we want to find the smallest positive integer n such that

$$\sum_{i=0}^{c}\left(n_{c_i}\right)p^i(1-p)^{n-i}\leq 1-p^* \tag{6}$$

where $p = F(t;\sigma_0)$ given by Equation (4). Since Equation (4) depends only on the ratio t/σ, the experiment needs to specify only this ratio. If the number of observed failures before t is less than or equal to c, from (6) we obtain

$$F(t;\sigma)\leq F(t;\sigma_0) \Leftrightarrow \sigma\geq\sigma_0$$

That is, the true average life is more than the specified average and the lot is accepted as a good lot. The minimum values of n satisfying the inequality (6) have been obtain for p* = 0.75, 0.90, 0.95, 0.99 and t/σ_0 = 0.628, 0.942, 1.257, 1.571, 2.356, 3.141, 3.927, 4.712. The results are presented in Table 1 for $\alpha = 2$ and $\sigma = 1$.

If $p = F(t;\sigma)$ is small and n is large (as is true in some cases of our present work), the binomial probability is approximated by Poisson probability with parameter $\lambda = np$ so that the equation (6) can be written as

$$\sum_{i=0}^{c}\left(\frac{e^{-\lambda}\lambda^i}{i!}\right)\leq 1-p^* \tag{7}$$

where $\lambda = n\,F(t;\sigma)$. The minimum values of n satisfying the inequality (7) have also been obtained for the same combination of p^*, t/σ_0 as those used in inequality (6) and are given in Table 2 for $\alpha = 2$ and σ = 1.

2.1 Operating Characteristic function of Sampling Plan

The operating characteristic of the sampling plan $(n, c, t/\sigma_0)$ gives the probability of accepting the lot. It can be seen that operating characteristic is an increasing function of σ. For given p^*, t/σ_0, the choice of c and n will be made on the basis of operating characteristics. Values of operating characteristics as a function of σ/σ_0 for a few sampling plans for selective value of c = 2 from Table 1 are calculated and are given in Table 3.

For a given value of the producer's risk say 0.05, one may be interested in knowing what value of σ/σ_0 will ensure producer's risk less than or equal to 0.05, if a sampling plan under discussion is adopted. It should be noted that the probability p may be obtained as a function of σ/σ_0, as $p = F(t/\sigma) = F[(t/\sigma_0)/(\sigma_0/\sigma)]$. The value σ/σ_0 is the smallest positive number for which the following inequality holds;

$$\sum_{i=0}^{c}\left(n_{c_i}\right)p^i\,(1-p)^{n-i} \geq 0.95 \tag{8}$$

For a given sampling plan $(n, c, t/\sigma_0)$ at specified confidence level p^* (i.e., consumer's risk $(1-p^*)$, we have computed the minimum values of σ/σ_0 satisfying the inequality (8) and are given in Table 4.

III TABLES DESCRIPTION

By assuming the lifetime models as Pareto-Rayleigh model with $\alpha = 2$, σ = 1 and that the experimenter is interested in establishing that the true unknown average life is at least 1000 hours with confidence $p^* = 0.75$. It is desired to stop the experiment at $t = 628$ hours. Then, for an acceptance number $c = 2$, the required n in Table 1 is 12. If, during 628 hours, no more than 2 failures out of 12 are observed, then the experimenter can assert, with a confidence level of 0.75 that the average life is at least 1000 hours. If the Poisson approximation to Binomial probability is used, the value of $n = 13$ is obtained from Table 2 for the same situation.

In general, all the values of n tabulated by us are found to be less than the corresponding values of n tabulated in Kantam *et. al.* [5] (2001) for log-logistic model.

For the sampling plan (n =12, c = 2, t/σ_0 = 0.628) and confidence level p^* = 0.75 under Pareto-Rayleigh distribution with α = 2 and σ = 1 the values of the operating characteristic function from Table 3 are as follows:

σ/σ_0	2	4	6	8	10	12
$L(p)$	0.9093	0.9974	0.9997	1.000	1.000	1.000

The above values show that if the true mean life time is twice the required mean life time (σ/σ_0 = 2) the producer's risk is approximately 0.0907. The producer's risk is 0.003 when the true mean life is 6 times or more the specified mean life ($\sigma/\sigma_0 \geq 6$).

From Table 4, we can get the values of the ratio σ/σ_0 for various choices of c, t/σ_0 in order that the producer's may not exceed 0.05. For example if $p^* = 0.75$, $t/\sigma_0 = 0.628$, $c = 2$, table 4 gives a reading of 2.28. This means the product can have an average life of 2.28 times the required average life time in order that under the above acceptance sampling plan the product is accepted with probability of at least 0.95. The actual average life time necessary to accept 95 percent of the lot is provided in Table 4.

3.1 Discussion of results through an example

Consider the following ordered failure times of the release of a software given in terms of hours from starting of the execution of the software up to the time at which a failure of the software is occurred Wood [15]. This data can be regarded as an ordered sample of size n = 10 with observations: 519, 968, 1430, 1893, 2490, 3058, 3625, 4422, 5218 and 5823.

Let the required average life time be 1000 hours and the testing time be $t = 628$ hours, this leads to rate of $t/\sigma_0 = 0.628$ with a corresponding sample size $n = 10$ and an acceptance number $c = 1$, which are obtained from Table 1 for $p^* = 0.90$. Therefore, the sampling plan for the above sample data is ($n = 10$, $c = 1$, $t/\sigma_0 = 0.628$). For this sampling plan, based on the above 10 sample observations, we have to decide whether to accept the product or reject it. We accept the product only if the number of failures before 628 hours is less than or equal to 1. However, the confidence level is assured by the sampling plan only if the given life times follow Pareto-Rayleigh distribution. In order to confirm that the given sample is generated by lifetimes following at least approximately the Pareto-Rayleigh distribution, we have compared the sample quantiles and the corresponding population quantiles and found a satisfactory agreement. Thus, the adoption of the decision rule of the sampling plan seems to be justified. In the sample of 10 units, we noticed only one failure at 519 hours before $t = 628$ hours. Therefore we accept the product.

Table 1

Minimum sample size for the specified ratio t/σ_0, confidence level p*, acceptance number c, α = 2, σ = 1 using the Binomial approximation.

P*	c	t/σ_0=0.628	0.942	1.257	1.571	2.356	3.141	3.927	4.712
0.75	0	4	2	2	1	1	1	1	1
	1	9	5	3	3	3	2	2	2
	2	12	7	5	4	4	3	3	3
	3	16	9	7	6	6	4	4	4
	4	20	11	8	7	7	5	5	5
	5	24	13	10	8	8	6	6	6
	6	27	16	11	10	10	7	7	7
	7	31	18	13	11	11	8	8	8
	8	35	20	15	12	12	9	9	9
	9	38	22	16	14	14	11	10	10
	10	42	24	18	15	15	12	11	11
0.9	0	7	4	2	2	1	1	1	1
	1	12	6	4	4	3	2	2	2
	2	16	9	6	5	4	3	3	3
	3	21	11	8	6	5	5	4	4

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	4	25	14	10	8	6	6	5	5
	5	29	16	11	9	7	7	6	6
	6	33	18	13	11	9	8	7	7
	7	37	20	15	12	10	9	9	8
	8	41	23	16	13	11	10	10	9
	9	45	25	18	15	12	11	11	10
	10	49	27	20	16	13	12	12	11
0.95	0	9	5	3	2	2	1	1	1
	1	14	8	5	4	3	3	2	2
	2	19	10	7	6	4	4	3	3
	3	24	13	9	7	5	5	5	4
	4	28	15	11	9	7	6	6	5
	5	32	18	12	10	8	7	7	6
	6	37	20	14	12	9	8	8	7
	7	41	22	16	13	10	9	9	9
	8	45	25	18	14	11	10	10	10
	9	49	27	19	16	12	11	11	11
	10	53	29	21	17	14	12	12	12
0.99	0	13	7	4	3	2	2	2	1
	1	19	10	7	5	4	3	3	3
	2	25	13	9	7	5	4	4	4
	3	30	16	11	9	6	5	5	5
	4	35	18	13	10	7	7	6	6
	5	40	21	15	12	9	8	7	7
	6	44	24	16	13	10	9	8	8
	7	49	26	18	15	11	10	9	9
	8	53	29	20	16	12	11	10	10
	9	57	31	22	18	14	12	11	11
	10	62	33	24	19	15	13	13	12

Table 2

Minimum sample size for the specified ratio t/σ_0, confidence level p^*, acceptance number c, $\alpha = 2$, $\sigma = 1$ using the Poisson approximation.

P*	c	t/σ_0=0.628	0.942	1.257	1.571	2.356	3.141	3.927	4.712
0.75	**0**	5	3	3	2	2	2	2	2
	1	9	6	4	4	3	3	3	3
	2	13	8	6	5	5	5	4	4
	3	17	10	8	7	6	6	6	6
	4	21	13	10	8	7	7	7	7
	5	25	15	11	10	8	8	8	8
	6	29	17	13	11	10	9	9	9
	7	33	19	15	13	11	10	10	10
	8	36	21	16	14	12	12	11	11
	9	40	23	18	15	13	13	13	12
	10	44	26	19	17	15	14	14	14
0.9	**0**	8	5	4	3	3	3	3	3
	1	13	8	6	5	5	5	4	4
	2	18	11	8	7	6	6	6	6
	3	23	13	10	9	8	7	7	7
	4	27	16	12	10	9	9	9	9
	5	31	18	14	12	10	10	10	10
	6	35	21	16	14	12	11	11	11

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	7	39	23	18	15	13	13	12	12
	8	43	25	19	17	14	14	14	14
	9	47	28	21	18	16	15	15	15
	10	51	30	23	20	17	16	16	16
0.95	**0**	10	6	5	4	4	4	4	4
	1	16	10	7	6	6	5	5	5
	2	21	13	10	8	7	7	7	7
	3	26	15	12	10	9	8	8	8
	4	31	18	14	12	10	10	10	10
	5	35	21	16	14	12	11	11	11
	6	40	23	18	15	13	13	13	12
	7	44	26	20	17	15	14	14	14
	8	48	28	21	19	16	15	15	15
	9	52	31	23	20	17	17	16	16
	10	57	33	25	22	19	18	18	18
0.99	**0**	16	9	7	6	5	5	5	5
	1	22	13	10	9	8	7	7	7
	2	28	17	13	11	10	9	9	9
	3	34	20	15	13	11	11	11	11
	4	39	23	17	15	13	12	12	12
	5	44	26	20	17	15	14	14	14
	6	49	29	22	19	16	15	15	15
	7	53	31	24	21	18	17	17	17
	8	58	34	26	22	19	18	18	18
	9	63	37	28	24	21	20	20	19
	10	67	39	30	26	22	21	21	21

Table 3

Values of the operating characteristic function of the sampling plan (n, c, t/σ_0) for given confidence level p^* with $\alpha = 2$, $\sigma = 1$.

P*	**n**	**C**	**t/σ_0**	**$\sigma/\sigma_0 = 2$**	**4**	**6**	**8**	**10**	**12**
0.75	**12**	**2**	**0.628**	0.9093	0.9974	0.9997	1.0000	1.0000	1.0000
	7	**2**	**0.942**	0.8692	0.9955	0.9995	0.9999	1.0000	1.0000
	5	**2**	**1.257**	0.8334	0.9933	0.9993	0.9999	1.0000	1.0000
	4	**2**	**1.571**	0.8019	0.9906	0.9989	0.9998	0.9999	1.0000
	4	**2**	**2.356**	0.4344	0.9348	0.9906	0.9980	0.9994	0.9998
	3	**2**	**3.141**	0.4890	0.9281	0.9884	0.9974	0.9992	0.9997
	3	**2**	**3.927**	0.3108	0.8384	0.9667	0.9916	0.9974	0.9990
	3	**2**	**4.712**	0.1961	0.7235	0.9281	0.9795	0.9932	0.9974
0.9	**16**	**2**	**0.628**	0.8236	0.9937	0.9994	0.9999	1.0000	1.0000
	9	**2**	**0.942**	0.7650	0.9901	0.9989	0.9998	0.9999	1.0000
	6	**2**	**1.257**	0.7394	0.9875	0.9986	0.9997	0.9999	1.0000
	5	**2**	**1.571**	0.6546	0.9788	0.9975	0.9995	0.9999	1.0000
	4	**2**	**2.356**	0.4344	0.9348	0.9906	0.9980	0.9994	0.9998
	3	**2**	**3.141**	0.4890	0.9281	0.9884	0.9974	0.9992	0.9997
	3	**2**	**3.927**	0.3108	0.8384	0.9667	0.9916	0.9974	0.9990
	3	**2**	**4.712**	0.1961	0.7235	0.9281	0.9795	0.9932	0.9974
0.95	**19**	**2**	**0.628**	0.7493	0.9897	0.9989	0.9998	0.9999	1.0000
	10	**2**	**0.942**	0.7086	0.9864	0.9985	0.9997	0.9999	1.0000
	7	**2**	**1.257**	0.6410	0.9795	0.9976	0.9995	0.9999	1.0000
	6	**2**	**1.571**	0.5113	0.9620	0.9952	0.9990	0.9997	0.9999
	4	**2**	**2.356**	0.4344	0.9348	0.9906	0.9980	0.9994	0.9998
	4	**2**	**3.141**	0.1816	0.8022	0.9614	0.9906	0.9971	0.9989
	3	**2**	**3.927**	0.3108	0.8384	0.9667	0.9916	0.9974	0.9990

	3	2	**4.712**	0.1961	0.7235	0.9281	0.9795	0.9932	0.9974
0.99	25	2	**0.628**	0.5940	0.9781	0.9975	0.9995	0.9999	1.0000
	13	2	**0.942**	0.5400	0.9711	0.9966	0.9993	0.9998	0.9999
	9	2	**1.257**	0.4558	0.9573	0.9947	0.9989	0.9997	0.9999
	7	2	**1.571**	0.3857	0.9402	0.9921	0.9984	0.9995	0.9998
	5	2	**2.356**	0.2329	0.8698	0.9788	0.9952	0.9986	0.9995
	4	2	**3.141**	0.1816	0.8022	0.9614	0.9906	0.9971	0.9989
	4	2	**3.927**	0.0695	0.6177	0.8990	0.9714	0.9906	0.9964
	4	2	**4.712**	0.0268	0.4344	0.8021	0.9348	0.9765	0.9906

Table 4

Minimum ratio of true σ and required σ_0 for the acceptability of a lot with producer's risk of 0.05 for $\alpha = 2$, $\sigma = 1$

P*	C	t/σ_0 =0.628	0.942	1.257	1.571	2.356	3.141	3.927	4.712
0.75	0	5.54	5.87	7.83	6.90	10.34	13.78	29.11	20.68
0.75	1	3.06	3.31	3.24	4.05	4.54	6.05	10.41	9.08
0.75	2	2.28	2.50	2.68	2.84	3.28	4.38	6.60	6.56
0.75	3	2.02	2.15	2.41	2.69	3.45	3.62	7.11	5.43
0.75	4	1.87	1.95	2.07	2.31	2.99	3.18	5.76	4.77
0.75	5	1.78	1.82	2.00	2.06	2.69	2.88	4.90	4.32
0.75	6	1.67	1.80	1.82	2.09	2.47	2.67	4.29	4.00
0.75	7	1.62	1.72	1.80	1.94	2.30	2.50	3.85	3.76
0.75	8	1.58	1.66	1.78	1.81	2.17	2.37	3.50	3.56
0.75	9	1.53	1.61	1.68	1.85	2.06	2.75	3.22	3.40
0.75	10	1.51	1.57	1.68	1.76	1.97	2.63	3.65	3.26
0.90	0	7.33	8.31	7.83	9.78	10.34	13.78	17.23	20.68
0.90	1	3.56	3.67	3.88	4.84	6.07	6.05	7.57	9.08
0.90	2	2.67	2.90	3.02	3.35	4.26	4.38	5.47	6.56
0.90	3	2.35	2.43	2.65	2.69	3.45	4.60	4.53	5.43
0.90	4	2.13	2.27	2.43	2.58	2.99	3.99	3.97	4.77
0.90	5	1.98	2.08	2.15	2.29	2.69	3.58	3.60	4.32
0.90	6	1.87	1.95	2.08	2.27	2.83	3.29	3.34	4.00
0.90	7	1.80	1.85	2.02	2.10	2.62	3.07	3.83	3.76
0.90	8	1.74	1.83	1.88	1.96	2.47	2.89	3.61	3.56
0.90	9	1.69	1.76	1.85	1.98	2.34	2.75	3.43	3.40
0.90	10	1.65	1.71	1.83	1.88	2.23	2.63	3.28	3.26
0.95	0	8.32	9.29	9.60	9.78	14.67	13.78	17.23	20.68
0.95	1	3.86	4.30	4.42	4.84	6.07	8.09	7.57	9.08
0.95	2	2.93	3.09	3.33	3.78	4.26	5.67	5.47	6.56
0.95	3	2.53	2.69	2.86	3.02	3.45	4.60	5.75	5.43
0.95	4	2.26	2.37	2.60	2.82	3.46	3.99	4.98	4.77
0.95	5	2.09	2.24	2.29	2.50	3.09	3.58	4.48	4.32
0.95	6	2.00	2.09	2.19	2.44	2.83	3.29	4.11	4.00
0.95	7	1.90	1.97	2.12	2.25	2.62	3.07	3.83	4.60
0.95	8	1.83	1.93	2.06	2.10	2.47	2.89	3.61	4.33
0.95	9	1.77	1.85	1.93	2.10	2.34	2.75	3.43	4.12
0.95	10	1.73	1.79	1.90	1.99	2.45	2.63	3.28	3.94
0.99	0	10.00	11.00	11.09	11.99	14.67	19.56	24.45	20.68
0.99	1	4.52	4.85	5.34	5.52	7.26	8.09	10.12	12.14
0.99	2	3.39	3.58	3.87	4.16	5.01	5.67	7.09	8.51
0.99	3	2.85	3.03	3.25	3.58	4.03	4.60	5.75	6.90
0.99	4	2.55	2.64	2.89	3.04	3.46	4.62	4.98	5.98
0.99	5	2.36	2.46	2.66	2.86	3.44	4.12	4.48	5.37
0.99	6	2.20	2.33	2.40	2.59	3.13	3.77	4.11	4.93

0.99	**7**	2.10	2.19	2.30	2.52	2.90	3.50	3.83	4.60
0.99	**8**	2.01	2.12	2.22	2.35	2.72	3.29	3.61	4.33
0.99	**9**	1.93	2.02	2.15	2.31	2.78	3.11	3.43	4.12
0.99	**10**	1.89	1.95	2.10	2.19	2.64	2.97	3.71	3.94

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