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ACCEPTANCE SAMPLING BASED ON TRUNCATED LIFE TESTS IN THE PARETO DISTRIBUTION OF THE SECOND KIND

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Abstract

We develop acceptance sampling plans assuming that the life test is truncated at a pre-assigned time. The life times of the test units are assumed to follow the Pareto distribution of the second kind. The minimum sample size necessary to ensure the specified average life is obtained and the operating characteristic values of the sampling plans and producer's risk are presented. An illustrative example is given.

1. Introduction

The Pareto distribution was first introduced as a model for incomes (Pareto [10]). Recently, several forms of the distribution have been studied by many authors including Davis and Feldstein [3], Cohen and Whitten [2] and Grimshaw [6]. The Pareto distribution of the second kind also known as Lomax or Pearson's type VI distribution has been found to have many applications in survival and biomedical sciences (Bain and Engelhardt [1]). However, little attention has been paid to acceptance sampling based on life tests for this distribution. Acceptance sampling is one of the major fields in statistical quality control. It is used by the

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consumer to decide whether to accept or reject lots of products shipped from the producer. Acceptance sampling is often used when the inspection of the product is costly or destructive, more details are given by Duncan [4].

The problem we are considering is that of finding the minimum sample size necessary to ensure a certain average life when the life test is terminated at a pre-assigned time (t) and when the number of failures does not exceed a given acceptance number (c). The lot is accepted if the specified average life can be established with a pre-assigned probability (P^*) specified by the consumer. This kind of life tests is discussed by Sobel and Tischendrof [11] for the exponential model. Weibull model is considered by Goode and Kao [5], while Gupta and Groll [7] studied the Gamma model. Kantam and Rosaiah [8] and Kantam et al. [9] investigated the half logistic and the log-logistic distributions. In Section 2, we shall give the proposed acceptance sampling plans and the operating characteristic. The results and a descriptive example are given in Section 3.

2. The Sampling Plans

The cumulative distribution function and the probability density function of the Pareto distribution of the second kind are given respectively by

$$F(t, \sigma, \lambda) = 1 - \left(1 + \frac{t}{\sigma}\right)^{-\lambda}, \quad t > 0, \ \sigma, \lambda > 0. \tag{1}$$

$$f(t, \sigma, \lambda) = \frac{\lambda t}{\sigma}\left(1 + \frac{t}{\sigma}\right)^{-(\lambda+1)}, \quad t > 0, \ \sigma, \lambda > 0. \tag{2}$$

A sampling plan consists of

n : The number of units on test.

c : An acceptance number such that if c or fewer failures occur during the test time (t), the lot is accepted.

t/σ_0 : where σ_0 is the specified average life.

The consumer risk is fixed such that it does not exceed $1 - P^*$. Assume that the lot is sufficiently large and it can be considered as infinite so that the theory of the binomial distribution is applied. What we want is the minimum sample size (n) such that

$$\sum_{i=0}^{c} \binom{n}{i} p^i (1-p)^{n-i} \leq 1 - P^*, \tag{3}$$

where $p = F(t, \sigma_0)$ and we took $\lambda = 2$. Notice that p is a function of t/σ_0. Thus the experiment needs only to specify this ratio. Minimum values of n satisfying inequality (3) were obtained for $P^* = 0.75$, 0.9, 0.95, 0.99, and $t/\sigma_0 = 0.628$, 0.942, 1.257, 1.571, 2.356, 3.141, 3.927, 4.712. This choice is consistent with that of Gupta and Groll [7] and Kantam and Rosaiah [8, 9].

The operating characteristic of the sampling plan $(n, c, t/\sigma_0)$ gives the probability of accepting the lot. This probability is given by

$$L(p) = \sum_{i=0}^{c} \binom{n}{i} p^i (1-p)^{n-i}, \tag{4}$$

where $p = F(t, \sigma)$, $(\lambda = 2)$, considered as a function of σ. Values of the operating characteristic as a function of σ/σ_0 for some selected sampling plans are given in Table 2.

The producer's risk is the probability of rejecting the lot when $\sigma \geq \sigma_0$. Under the sampling plan under consideration, and given a value for the producer's risk, say 0.05, one may be interested in knowing what value of σ/σ_0 will ensure the producer's risk less than or equal to 0.05. This value of σ/σ_0 is the smallest number σ/σ_0 for which $F((t/\sigma_0)(\sigma_0/\sigma))$ satisfies the inequality

$$\sum_{i=0}^{c} \binom{n}{i} p^i (1-p)^{n-i} \geq 0.95. \tag{5}$$

For a given sampling plan $(n, c, t/\sigma_0)$ at specified confidence level P^*

minimum values of σ/σ_0 satisfying inequality (5) are computed and presented in Table 3 with $\lambda = 2$.

Tables 1, 2 and 3 can be generated for any other value of λ. A Mathematica program that do this is available from the author upon request.

3. The Results

The results are given in Tables 1-6. Tables 1, 3 and 5 are for $\lambda = 2$, while Tables 2, 4 and 6 are for $\lambda = 3$. Here we shall explain and discuss the results by the way of an example. We will consider the case when $\lambda = 2$. Assume that an experimenter wants to establish that the true unknown average life is at least 1000 hours with confidence $P^* = 0.95$. The experiment will be stopped at $t = 942$ hours. Let the acceptance number be $c = 2$. Then the required n from Table 1 is 6. If during 942 hours no more than 2 failures out of 6 are observed, then the experimenter can assert with confidence 0.95 that the average life is at least 1000 hours.

For the sampling plan $(n = 6, c = 2, t/\sigma_0 = 0.942)$ the operating characteristic (O.C) values from Table 3 are

σ/σ_0	2	4	6	8	10	12
O.C	0.01813	0.21017	0.44601	0.61875	0.73283	0.80772

This means that if the true mean life is twice the specified mean life, then the producer's risk is about 0.98 while it is about 0.2 when the true mean life is 12 times the specified mean life.

Table 5 can be used to get the value of σ/σ_0 for various choices of c, t/σ_0 in order that the producer's risk may not exceed 0.05. For example, the value of σ/σ_0 is 10.87 for $c = 2$, $t/\sigma_0 = 0.942$, $P^* = 0.95$. This means that the product should have an average life of 10.87 times the specified average life of 1000 hours in order that the product be accepted with probability 0.95.

Similar interpretations hold for the results in Tables 2, 4, and 6 corresponding to the case when $\lambda = 3$.

Table 1. Minimum values of n necessary to ensure an average life exceeding σ_0 with probability P^* and an acceptance number c. $\lambda = 2$

		t/σ_0							
P^*	c	0.628	0.942	1.257	1.571	2.356	3.141	3.972	4.712
0.75	0	2	2	1	1	1	1	1	1
	1	4	3	3	3	2	2	2	2
	2	6	5	4	4	3	3	3	3
	3	7	6	6	5	5	4	4	4
	4	9	8	7	6	6	6	5	5
	5	11	9	8	8	7	7	6	6
	6	13	11	10	9	8	8	8	7
	7	14	12	11	10	9	9	9	8
	8	16	13	12	11	10	10	10	9
	9	18	15	13	13	12	11	11	11
	10	20	16	15	14	13	12	12	12
0.90	0	3	2	2	2	1	1	1	1
	1	5	4	4	3	3	3	2	2
	2	7	6	5	5	4	4	4	3
	3	9	7	6	6	5	5	5	5
	4	11	9	8	7	6	6	6	6
	5	13	10	9	9	8	7	7	7
	6	15	12	11	10	9	8	8	8
	7	17	14	12	11	10	9	9	9

	8	18	15	13	12	11	11	10	10
	9	20	17	15	14	12	12	11	11
	10	22	18	16	15	14	13	12	12
0.95	0	4	3	2	2	2	2	1	1
	1	6	5	4	4	3	3	3	3
	2	8	6	6	5	4	4	4	4
	3	10	8	7	6	6	5	5	5
	4	12	10	9	8	7	6	6	6
	5	14	11	10	9	8	8	7	7
	6	16	13	11	11	9	9	8	8
	7	18	15	13	12	11	10	10	9
	8	20	16	14	13	12	11	11	10
	9	22	18	16	14	13	12	12	11
	10	24	19	17	16	14	13	13	13
0.99	0	5	4	3	3	2	2	2	2
	1	8	6	5	5	4	3	3	3
	2	10	8	7	6	5	5	4	4
	3	12	10	8	8	7	6	6	5
	4	15	12	10	9	8	7	7	7
	5	17	13	12	11	9	8	8	8
	6	19	15	13	12	10	10	9	9
	7	21	17	15	13	12	11	10	10
	8	23	18	16	15	13	12	11	11
	9	25	20	17	16	14	13	13	12
	10	27	22	19	17	15	14	14	13

Table 2. Minimum values of n necessary to ensure an average life exceeding σ_0 with probability P^* and an acceptance number c. $\lambda = 3$

		t/σ_0							
P^*	c	0.628	0.942	1.257	1.571	2.356	3.141	3.972	4.712
0.75	0	1	1	1	1	1	1	1	1
	1	3	3	2	2	2	2	2	2
	2	4	4	3	3	3	3	3	3
	3	6	5	5	4	4	4	4	4
	4	7	6	6	6	5	5	5	5
	5	9	7	7	7	6	6	6	6
	6	10	9	8	8	7	7	7	7
	7	11	10	9	9	8	8	8	8
	8	13	11	10	10	9	9	9	9
	9	14	12	11	11	10	10	10	10
	10	16	14	13	12	12	11	11	11
0.90	0	2	2	1	1	1	1	1	1
	1	4	3	3	3	2	2	2	2
	2	5	4	4	4	3	3	3	3
	3	7	6	5	5	5	4	4	4
	4	8	7	6	6	6	5	5	5
	5	10	8	8	7	7	6	6	6
	6	11	10	9	8	8	7	7	7
	7	13	11	10	9	9	9	8	8
	8	14	12	11	11	10	10	9	9

	9	16	13	12	12	11	11	10	10
	10	17	15	13	13	12	12	11	11
0.95	0	3	2	2	2	1	1	1	1
	1	4	4	3	3	3	2	2	2
	2	6	5	4	4	4	3	3	3
	3	8	6	6	5	5	5	4	4
	4	9	8	7	6	6	6	5	5
	5	11	9	8	8	7	7	6	6
	6	12	10	9	9	8	8	8	7
	7	14	12	10	10	9	9	9	8
	8	15	13	12	11	10	10	10	9
	9	17	14	13	12	11	11	11	11
	10	18	15	14	13	12	12	12	12
0.99	0	4	3	2	2	2	2	1	1
	1	6	4	4	3	3	3	3	3
	2	7	6	5	5	4	4	4	4
	3	9	7	7	6	5	5	5	5
	4	11	9	8	7	6	6	6	6
	5	12	10	9	8	8	7	7	7
	6	14	12	10	10	9	8	8	8
	7	16	13	12	11	10	9	9	9
	8	17	14	13	12	11	10	10	10
	9	19	16	14	13	12	12	11	11
	10	20	17	15	14	13	13	12	12

Table 3. Operating characteristic values for the sampling plan $(n, c, t/\sigma_0)$ for a given P^* when $c = 2$. $\lambda = 2$

			σ/σ_0					
P^*	n	t/σ_0	2	4	6	8	10	12
0.75	6	0.628	0.0426	0.32368	0.57489	0.72859	0.81953	0.875
	5	0.942	0.10036	0.44008	0.67111	0.79781	0.86869	0.9105
	4	1.257	0.14904	0.50075	0.71333	0.82557	0.88733	0.92344
	4	1.571	0.18164	0.5291	0.72981	0.83514	0.89318	0.92721
	3	2.356	0.19762	0.51797	0.71052	0.81704	0.87825	0.91532
	3	3.141	0.11127	0.37265	0.57731	0.71056	0.79588	0.85168
	3	3.972	0.30418	0.58588	0.74433	0.83354	0.88632	0.91919
	3	4.712	0.24341	0.50847	0.6768	0.77971	0.84429	0.88633
0.90	7	0.628	0.0051	0.12932	0.34414	0.52736	0.65849	0.74889
	6	0.942	0.0327	0.2728	0.51667	0.67903	0.7805	0.8448
	5	1.257	0.07574	0.37495	0.60957	0.74986	0.83279	0.88359
	5	1.571	0.08186	0.3733	0.60233	0.74182	0.82562	0.87761
	4	2.356	0.06656	0.31064	0.52921	0.67694	0.77255	0.83521
	4	3.141	0.11127	0.37265	0.57731	0.71056	0.79588	0.85168
	4	3.972	0.06649	0.26955	0.46413	0.60886	0.71048	0.78158
	3	4.712	0.04189	0.19762	0.37259	0.51797	0.62847	0.71052
0.95	8	0.628	0.00209	0.08658	0.27282	0.4536	0.5931	0.69407
	6	0.942	0.01813	0.21017	0.44601	0.61875	0.73283	0.80772
	6	1.257	0.03704	0.27299	0.51026	0.6707	0.77254	0.83788
	5	1.571	0.03491	0.25282	0.48224	0.64403	0.74993	0.81943

	4	2.356	0.06656	0.31064	0.52921	0.67694	0.77255	0.83521
	4	3.141	0.11127	0.37265	0.57731	0.71056	0.79588	0.85168
	4	3.972	0.06649	0.26955	0.46413	0.60886	0.71048	0.78158
	4	4.712	0.04189	0.19762	0.37259	0.51797	0.62847	0.71052
0.99	10	0.628	0.00008	0.01916	0.11101	0.24917	0.38739	0.50587
	8	0.942	0.00151	0.06676	0.22814	0.39955	0.54031	0.6468
	7	1.257	0.00815	0.1357	0.34021	0.51618	0.64482	0.73532
	6	1.571	0.0143	0.16587	0.37664	0.54837	0.67079	0.75575
	5	2.356	0.02051	0.17379	0.37342	0.53759	0.65716	0.74191
	5	3.141	0.02727	0.18176	0.37197	0.52927	0.64583	0.72994
	4	3.972	0.01236	0.10845	0.25941	0.40669	0.52917	0.62534
	4	4.712	0.0061	0.06656	0.18172	0.31064	0.42905	0.52921

Table 4. Operating characteristic values for the sampling plan $(n,\ c,\ t/\sigma_0)$ for a given P^* when $c = 2.$ $\lambda = 3$

			σ/σ_0					
P^*	n	t/σ_0	2	4	6	8	10	12
0.75	6	0.628	0.59385	0.86933	0.9445	0.97169	0.9837	0.98979
	5	0.942	0.37336	0.73143	0.86933	0.92795	0.95638	0.97169
	4	1.257	0.54621	0.82487	0.91779	0.95543	0.97328	0.98276
	4	1.571	0.43987	0.75013	0.87329	0.928	0.95544	0.9706
	3	2.356	0.26317	0.57685	0.75021	0.8434	0.89625	0.92803
	3	3.141	0.16644	0.44002	0.63108	0.75025	0.82501	0.87336
	3	3.972	0.1109	0.33805	0.52691	0.6596	0.75018	0.81256
	3	4.712	0.07729	0.26317	0.43997	0.57685	0.67723	0.75021

0.90	7	0.628	0.38998	0.75804	0.88768	0.93987	0.96431	0.97717
	6	0.942	0.37336	0.73143	0.86933	0.92795	0.95638	0.97169
	5	1.257	0.23099	0.59343	0.77839	0.86912	0.91707	0.9444
	5	1.571	0.14466	0.47267	0.68409	0.80186	0.86917	0.90963
	4	2.356	0.26317	0.57685	0.75021	0.8434	0.89625	0.92803
	4	3.141	0.16644	0.44002	0.63108	0.75025	0.82501	0.87336
	4	3.972	0.1109	0.33805	0.52691	0.6596	0.75018	0.81256
	3	4.712	0.07729	0.26317	0.43997	0.57685	0.67723	0.75021
0.95	8	0.628	0.24022	0.63829	0.81744	0.89759	0.93739	0.95911
	6	0.942	0.18232	0.55656	0.75804	0.85754	0.91004	0.93987
	6	1.257	0.23099	0.59343	0.77839	0.86912	0.91707	0.9444
	5	1.571	0.14466	0.47267	0.68409	0.80186	0.86917	0.90963
	4	2.356	0.04922	0.26045	0.47279	0.62683	0.73125	0.80193
	4	3.141	0.16644	0.44002	0.63108	0.75025	0.82501	0.87336
	4	3.972	0.1109	0.33805	0.52691	0.6596	0.75018	0.81256
	4	4.712	0.07729	0.26317	0.43997	0.57685	0.67723	0.75021
0.99	10	0.628	0.1412	0.52232	0.73927	0.84703	0.90376	0.93588
	8	0.942	0.08229	0.40202	0.63829	0.77351	0.85107	0.89759
	7	1.257	0.08502	0.38952	0.62082	0.75772	0.83827	0.8875
	6	1.571	0.04094	0.26726	0.49574	0.65453	0.75778	0.82531
	5	2.356	0.04922	0.26045	0.47279	0.62683	0.73125	0.80193
	5	3.141	0.0192	0.14477	0.3181	0.47284	0.59368	0.68424
	4	3.972	0.00841	0.0829	0.21353	0.35142	0.47274	0.57205
	4	4.712	0.00405	0.04922	0.14473	0.26045	0.37314	0.47279

Table 5. Minimum ratio of true mean life to specified mean life for the acceptability of a lot with producer's risk of 0.05. $\lambda = 2$

		t/σ_0							
P^*	c	0.628	0.942	1.257	1.571	2.356	3.141	3.972	4.712
0.75	0	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4
	1	11.92	12.49	16.67	20.83	17.47	23.29	29.11	29.11
	2	7.25	8.52	8.19	10.23	9.13	12.17	15.21	18.25
	3	4.62	5.5	7.34	6.74	10.1	8.33	10.41	12.49
	4	4.04	5.07	5.42	5.06	7.58	10.1	8.03	9.63
	5	3.67	4	4.32	5.4	6.11	8.15	6.6	7.92
	6	3.41	3.93	4.43	4.51	5.15	6.87	8.59	6.79
	7	2.9	3.35	3.8	3.89	4.48	5.97	7.46	5.97
	8	2.8	2.94	3.34	3.43	3.98	5.3	6.63	5.36
	9	2.72	2.99	2.98	3.73	4.62	4.79	5.99	7.18
	10	2.65	2.69	3.15	3.38	4.2	4.38	5.47	6.56
0.90	0	6.56	6.56	6.56	6.56	6.56	6.56	6.56	6.56
	1	15.49	17.88	23.86	20.83	20.83	20.83	29.11	29.11
	2	8.81	10.87	11.37	14.21	15.34	20.45	25.57	18.25
	3	6.49	6.92	7.34	9.17	10.1	13.47	16.83	20.2
	4	5.34	6.05	6.76	6.77	7.58	10.1	12.63	15.15
	5	4.65	4.76	5.34	6.67	8.09	8.15	10.18	12.22
	6	4.19	4.52	5.24	5.54	6.76	6.87	8.59	10.3
	7	3.87	4.34	4.47	4.75	5.83	5.97	7.46	8.95
	8	3.35	3.78	3.91	4.17	5.14	6.86	6.63	7.95

	9	3.19	3.71	3.98	4.36	4.62	6.15	5.99	7.18
	10	3.07	3.34	3.59	3.94	5.07	5.6	5.47	6.56
0.95	0	6.56	6.56	6.56	6.56	6.56	6.56	6.56	6.56
	1	19.04	23.23	23.86	29.82	29.82	29.82	29.82	29.82
	2	10.36	10.87	14.51	14.21	15.34	20.45	25.57	25.57
	3	7.42	8.33	9.24	9.17	13.74	13.47	16.83	20.2
	4	5.99	7.03	8.08	8.44	10.16	10.1	12.63	15.15
	5	5.14	5.5	6.35	6.67	8.09	10.79	10.18	12.22
	6	4.58	5.12	5.24	6.55	6.76	9.01	8.59	10.3
	7	4.19	4.83	5.14	5.59	7.12	7.77	9.71	8.95
	8	3.9	4.2	4.48	4.89	6.25	6.86	8.57	7.95
	9	3.67	4.07	4.47	4.36	5.59	6.15	7.69	7.18
	10	3.49	3.66	4.02	4.49	5.07	5.6	7	8.4
0.99	0	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4
	1	26.13	28.56	28.56	28.56	28.56	28.56	28.56	28.56
	2	13.45	15.53	17.62	18.13	21.31	28.4	25.57	25.57
	3	9.28	11.13	11.12	13.89	17.31	18.32	22.9	20.2
	4	7.92	8.98	9.38	10.09	12.66	13.54	16.92	20.31
	5	6.6	6.97	8.32	9.17	10.01	10.79	13.48	16.18
	6	5.75	6.29	6.82	7.54	8.3	11.07	11.26	13.51
	7	5.15	5.8	6.44	6.42	8.38	9.49	9.71	11.65
	8	4.71	5.02	5.6	6.3	7.33	8.33	8.57	10.28
	9	4.37	4.79	4.96	5.59	6.53	7.45	9.31	9.23
	10	4.11	4.6	4.88	5.03	5.91	6.75	8.44	8.4

Table 6. Minimum ratio of true mean life to specified mean life for the acceptability of a lot with producer's risk of 0.05. $\lambda = 3$

		t/σ_0							
P^*	c	0.628	0.942	1.257	1.571	2.356	3.141	3.972	4.712
0.75	0	15.71	15.71	15.71	15.71	15.71	15.71	15.71	15.71
	1	12.65	18.97	14.28	17.85	26.77	26.77	26.77	26.77
	2	6.29	9.43	7.6	9.5	14.24	18.98	23.73	28.47
	3	5.65	6.28	8.38	6.61	9.91	13.21	16.51	19.81
	4	4.21	4.77	6.36	7.94	7.75	10.33	12.91	15.49
	5	4.15	3.88	5.18	6.47	6.46	8.61	10.76	12.91
	6	3.47	4.27	4.41	5.51	5.59	7.46	9.32	11.18
	7	2.99	3.71	3.86	4.83	4.98	6.63	8.29	9.95
	8	3.08	3.3	3.46	4.32	4.51	6.01	7.52	9.02
	9	2.76	2.98	3.15	3.93	4.15	5.52	6.91	8.29
	10	2.84	3.25	3.64	3.62	5.43	5.13	6.41	7.7
0.90	0	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
	1	18.04	18.97	25.31	25.31	26.77	26.77	26.77	26.77
	2	8.67	9.43	12.58	15.72	14.24	18.98	23.73	28.47
	3	7.07	8.47	8.38	10.47	15.71	13.21	16.51	19.81
	4	5.22	6.31	6.36	7.94	11.91	10.33	12.91	15.49
	5	4.91	5.07	6.77	6.47	9.7	8.61	10.76	12.91
	6	4.07	5.2	5.7	5.51	8.26	7.46	9.32	11.18
	7	4	4.49	4.95	4.83	7.24	9.65	8.29	9.95
	8	3.51	3.97	4.4	5.5	6.48	8.64	7.52	9.02

	9	3.5	3.57	3.97	4.97	5.89	7.86	6.91	8.29
	10	3.16	3.76	3.64	4.55	5.43	7.23	6.41	7.7
0.95	0	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
	1	18.04	27.05	25.31	25.31	25.31	25.31	25.31	25.31
	2	11.03	13.01	12.58	15.72	23.57	18.98	23.73	28.47
	3	8.49	8.47	11.3	10.47	15.71	20.94	16.51	19.81
	4	6.2	7.82	8.42	7.94	11.91	15.88	12.91	15.49
	5	5.65	6.23	6.77	8.46	9.7	12.93	10.76	12.91
	6	4.67	5.2	5.7	7.12	8.26	11	13.76	11.18
	7	4.49	5.25	4.95	6.19	7.24	9.65	12.06	9.95
	8	3.93	4.62	5.29	5.5	6.48	8.64	10.8	9.02
	9	3.86	4.14	4.76	4.97	5.89	7.86	9.82	11.78
	10	3.48	3.76	4.34	4.55	5.43	7.23	9.04	10.85
0.99	0	10.85	10.85	10.85	10.85	10.85	10.85	10.85	10.85
	1	28.72	27.05	27.05	27.05	27.05	27.05	27.05	27.05
	2	13.36	16.54	17.36	21.69	23.57	23.57	23.57	23.57
	3	9.89	10.61	14.16	14.12	15.71	20.94	26.17	26.17
	4	8.16	9.3	10.43	10.53	11.91	15.88	19.85	23.82
	5	6.39	7.36	8.31	8.46	12.68	12.93	16.17	19.4
	6	5.85	7.01	6.94	8.67	10.68	11	13.76	16.51
	7	5.47	5.99	7	7.48	9.27	9.65	12.06	14.47
	8	4.76	5.26	6.16	6.61	8.24	8.64	10.8	12.95
	9	4.58	5.25	5.52	5.95	7.45	9.92	9.82	11.78
	10	4.12	4.74	5.01	5.42	6.81	9.08	9.04	10.85

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