Loglogistic — a hazard that rises, then falls

Menu: Life Data ▸ Time Dependence ▸ Loglogistic distribution...

Part 1 — What the function does

What it calculates. The loglogistic model says the logarithm of a unit's life follows a logistic distribution: F(t) = 1/(1 + (t/e^μ)^(−1/s)). A life can never be below zero. When s is below 1, the hazard rises, peaks, then falls - a mix of wear-in and wear-out that no Weibull can produce; when s is 1 or more, it falls from the start and the mean is infinite. ReliaEn fits μ (the log of the median) and s (the spread of ln t) by maximum likelihood, with bounds.

What ReliaEn prints	What it tells you
μ̂ and **ŝ** with bounds	The centre and the spread of ln t - not of t itself
Median life = e^μ, **MTTF**	Two centres; the MTTF lies above the median because the right tail is long
B-life and the **percentile table** with bounds	By what age a share of units has failed
Probability plot	Whether the points lie on the loglogistic line
R(t) and hazard	How reliability falls, and where the hazard peaks

From which data. The failure ages in one worksheet column, one row per failed unit, each above 0; the ages of units still running, if any, in a different column. The form also reads inspection intervals (chapter 2.9).

When an engineer uses it. When the failure rate climbs at first and then eases: units that survive a middle period become safer with age.

When not to use it.

Situation	Use instead
The hazard keeps rising with age	Life Data ▸ Time Dependence ▸ Weibull (2P) distribution...
Failure comes from damage that multiplies, such as a fatigue crack	Life Data ▸ Time Dependence ▸ Lognormal distribution...
The failure rate does not change with age	Life Data ▸ Time Dependence ▸ Exponential distribution...

Part 2 — The example's input data

Setting. The same 14 pump couplings as chapter 2.10, whose logistic fit put about 5% of them below age 0. The reliability engineer fits them again with a model whose lives cannot go below zero.

Input	Value
Failure ages, hours (10)	42, 66, 87, 112, 128, 155, 176, 210, 240, 280
Survivor ages, hours (4)	50, 200, 300, 300
File in the worked-example zip	2-Loglogistic/Example-1.csv — columns Failure times (10) and Censored times (4)
Confidence % / B-life level %	95 / 10 — the values the form opens with

	① A	② B	C
1	42	50	
2	66	200	
3	87	300	
4	112	300	
5	128		
6	155		
7	176		
8	210		
9	240		
10	280		
11			

The example data in the worksheet

- ① Column A: the 10 failure ages, one per row, in hours.
- ② Column B: the 4 survivor ages.

Part 3 — How to use it, step by step

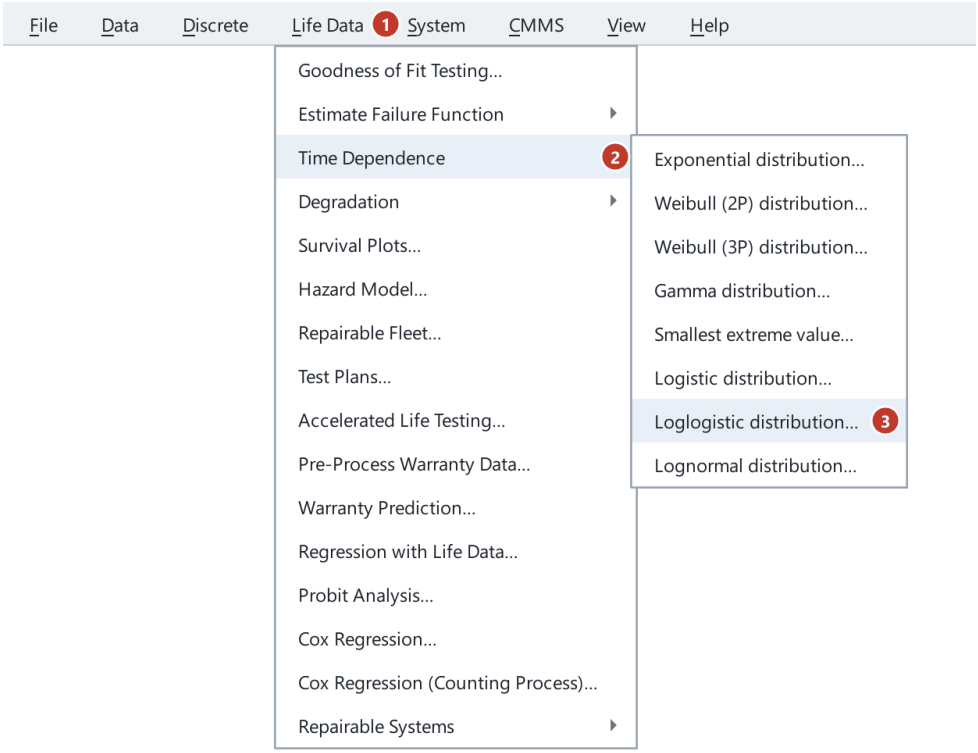
1. **Put the failure ages in column A and the survivor ages in column B.** Copy the values of Example-1.csv that stand under its headings Failure times and Censored times into columns A and B of the worksheet, starting at row 1.

	① A	② B	C
1	42	50	
2	66	200	
3	87	300	
4	112	300	
5	128		
6	155		
7	176		
8	210		
9	240		
10	280		
11			

Step 1 — the failure and survivor ages in columns A and B

- ① Column A: the 10 failure ages, 42 to 280.
- ② Column B: the 4 survivor ages, 50 to 300.

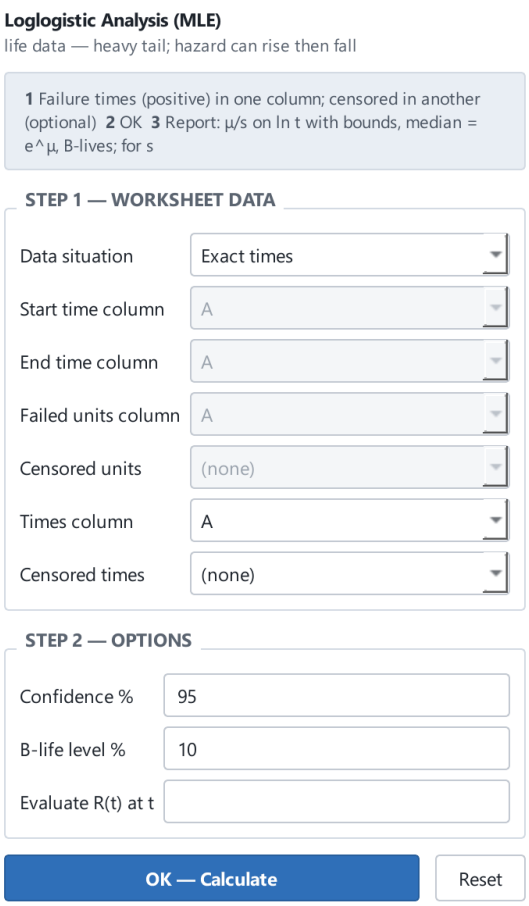
2. **Choose Life Data ▸ Time Dependence ▸ Loglogistic distribution...** in the menu bar. The form Loglogistic Analysis (MLE) opens in the left panel.



Step 2 — the menu path

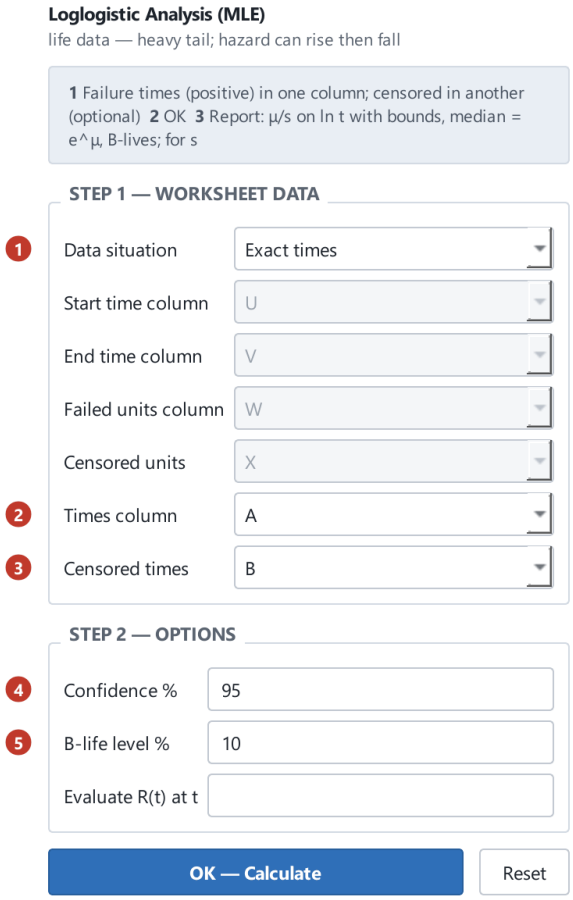
- ① Life Data: the menu.
- ② Time Dependence: the submenu.
- ③ Loglogistic distribution...: the entry to click.

The form as it opens, before any box is set:



Step 2 — the form as it opens

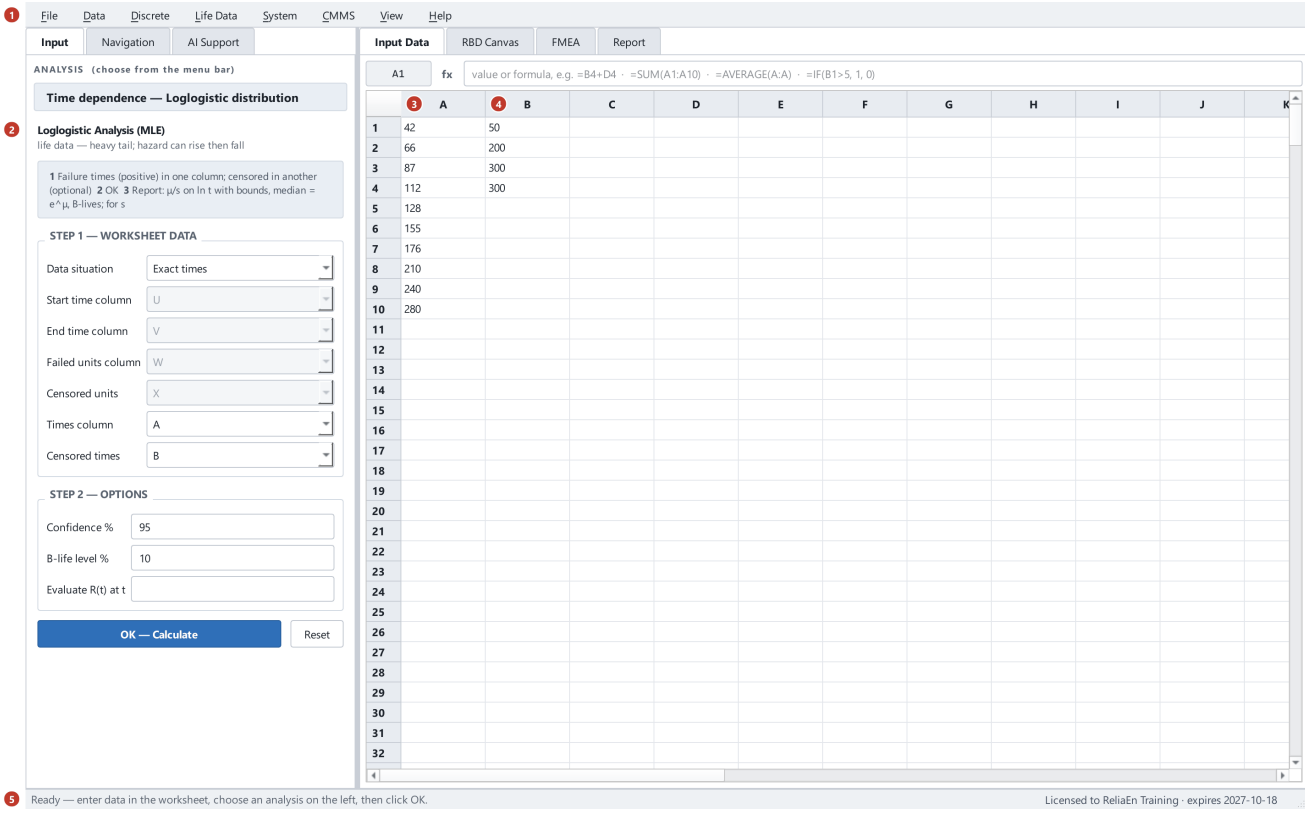
Steps 3 to 7 set or check the form's five boxes, marked ① to ⑤ in the picture:



Steps 3 to 7 — the form set for this example

3. ① **Check that Data situation reads Exact times.**
4. ② **In Times column, choose A.**
5. ③ **In Censored times, choose B.** Column B holds the four couplings removed still working.
6. ④ **Check that Confidence % reads 95.**
7. ⑤ **Check that B-life level % reads 10.** It sets the B-life in the results. Evaluate R(t) at t stays empty.

8. **Click OK — Calculate** at the foot of the form (② in the picture below). ReliaEn calculates and shows the report.



Step 8 — the window just before OK

- ① The menu bar: File, Data, Discrete, Life Data, System, CMMS, View, Help.
- ② The form, set as in steps 3 to 7; OK — Calculate at its foot.
- ③ Column A: the 10 failure ages.
- ④ Column B: the 4 survivor ages.
- ⑤ The status bar: Ready — enter data in the worksheet, choose an analysis on the left, then click OK. and Licensed to ReliaEn Training · expires 2027-10-18.

Part 4 — The report, card by card

Life Data — Loglogistic Analysis (MLE)

2026-11-02 20:32:10

F(t) = 1/(1 + (t/e^μ)^{−1/s})

The report's head

- The title Life Data — Loglogistic Analysis (MLE), the date and time of the run, and the model in one line: F(t) = 1/(1 + (t/e^μ)^{−1/s}).

	INPUT DATA	
1	n — units on test	14
2	r — failures	10
3	censored (survivors)	4
4	Data situation	exact times
5	Estimation	MLE (censored location-scale)

Input data

- ① n — units on test 14.
- ② r — failures 10.
- ③ censored (survivors) 4: the couplings removed still working.
- ④ Data situation exact times.
- ⑤ Estimation MLE (censored location-scale).

	RESULTS	
1	μ̂ — location	5.1505 (SE 0.2049) [4.7489, 5.5521]
2	ŝ — scale	0.4201 (SE 0.1091) [0.2525, 0.6990] (log-scale CI)
3	MTTF	235.04
4	Median life	172.52
5	B10 life	68.54 [37.67, 124.74]

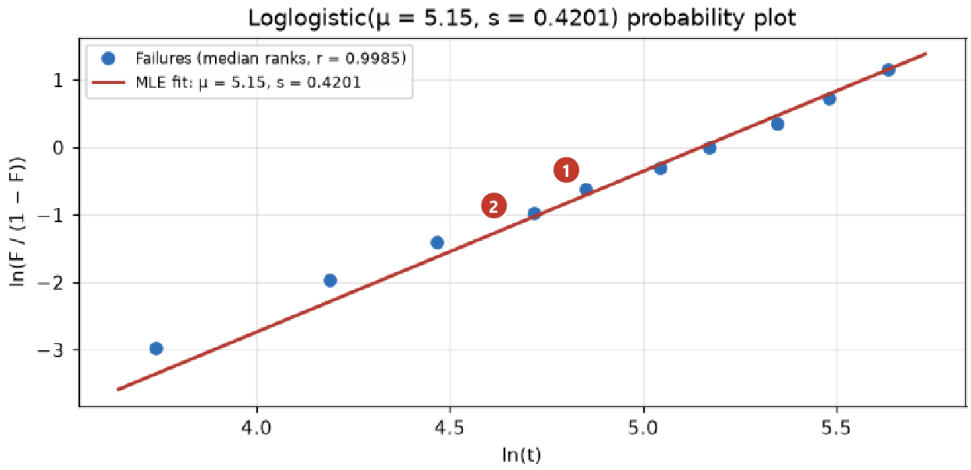
Results

- ① μ̂ — location 5.1505 (SE 0.2049) [4.7489, 5.5521]: the centre of ln t, in log hours.
- ② ŝ — scale 0.4201 (SE 0.1091) [0.2525, 0.6990] (log-scale CI): the spread of ln t; below 1, so the hazard rises, then falls.
- ③ MTTF 235.04: dragged up by the long right tail.
- ④ Median life 172.52: e^μ̂ - half the couplings have failed by this age.
- ⑤ B10 life 68.54 [37.67, 124.74]: one coupling in ten has failed by 69 hours, and both bounds are above zero.

	INTERPRETATION
1	Loglogistic life model (logistic on ln t): median = e^μ = 172.52 exactly. For s < 1 the hazard RISES THEN FALLS — a wear-in/wear-out mix no Weibull can produce; for s ≥ 1 it falls from the start and the mean is infinite (printed honestly).

Interpretation

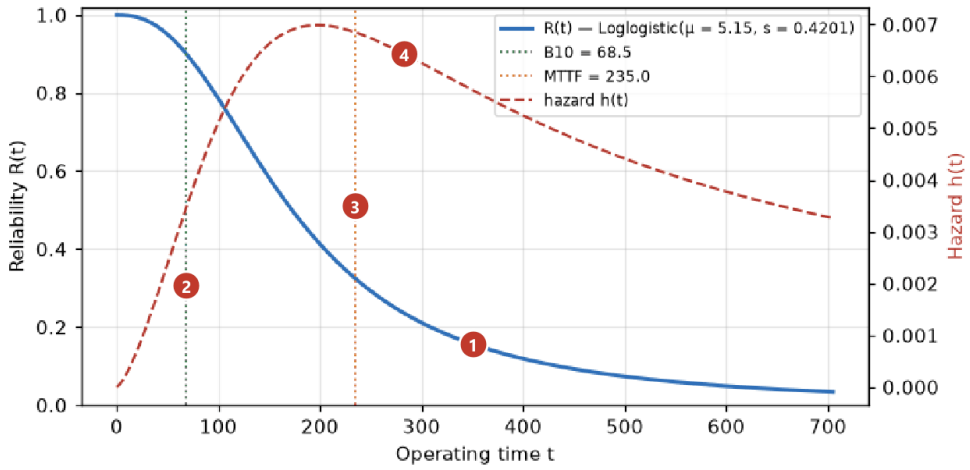
- ① ReliaEn's reading: Loglogistic life model (logistic on ln t): median = e^μ = 172.52 exactly. For s < 1 the hazard RISES THEN FALLS — a wear-in/wear-out mix no Weibull can produce; for s ≥ 1 it falls from the start and the mean is infinite (printed honestly).



Interactive Plot

Loglogistic(μ = 5.15, s = 0.4201) probability plot

- ① Failures (median ranks, r = 0.9985): the 10 failure ages on loglogistic paper, against ln t.
- ② MLE fit: μ = 5.15, s = 0.4201: the fitted line.



Interactive Plot

Reliability and hazard

- ① R(t) — Loglogistic(μ = 5.15, s = 0.4201): the share of couplings still working at each age. It starts at 1 at age 0.
- ② B10 = 68.5: where R crosses 90%.
- ③ MTTF = 235.0: the mean life; R there is about 0.32 - two couplings in three have failed by the mean.
- ④ hazard h(t): rising to a peak of about 0.007 per hour near 200 hours, then falling.

PERCENTILE TABLE — B-LIVES WITH BOUNDS

1 B_p = the age by which p% of units fail. Bounds by each family's own interval machinery; a — cell means no bound machinery exists for that family — the point estimate stands alone.

2 Percentile	3 B-life	4 95% bounds
1%	25.03	[8.864, 70.69]
5%	50.08	[24.24, 103.4]
5 10%	68.54	[37.67, 124.7]
25%	108.7	[69.17, 171]
50%	172.5	[115.5, 257.8]
75%	273.7	[169.7, 441.4]
90%	434.2	[229.6, 821]
95%	594.3	[275.7, 1,281]
99%	1,189	[401.8, 3,518]

Percentile table — B-lives with bounds

- ① B_p = the age by which p% of units fail. Bounds by each family's own interval machinery; a — cell means no bound machinery exists for that family — the point estimate stands alone.
- ② to ④ The columns Percentile, B-life, 95% bounds.
- ⑤ The 10% row: 68.54 [37.67, 124.7] - the B10 of the results card. Every row is above zero, from 25.03 at 1% to 1,189 at 99%.

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The report's foot

- ① The licence line Licensed to ReliaEn Training · RL-2026-0017: the licence the report was made under.

Part 5 — How to interpret the results

When the couplings fail. Half the couplings have failed by 172.52 hours (the median, e^μ̂). The MTTF, 235.04, sits well above the median because of the long right tail: by the mean age about two couplings in three have already failed, so report the median with its percentiles, not the mean alone. One coupling in ten has failed by 68.54 hours (B10).

How the failure rate behaves. With ŝ = 0.4201, below 1, the hazard rises to a peak near 200 hours and then falls: a coupling that has run past about 200 hours becomes less likely to fail in the next hour, not more. If the couplings wear out and the rate keeps climbing, this model is the wrong frame.

Against the logistic fit of chapter 2.10. The same ages give a straighter probability plot here (r = 0.9985 against 0.9712), and every life is above zero: B1 is 25.03 hours and B10's lower bound is 37.67, where the logistic gave -99.22 and -34.41. For an early-failure figure to plan with, these couplings are better read with the loglogistic.