Accelerated Life Test

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Motivation and Background for Accelerated Testing

- Modern products are designed to last for years or decades.
- Need timely information on high reliability products.

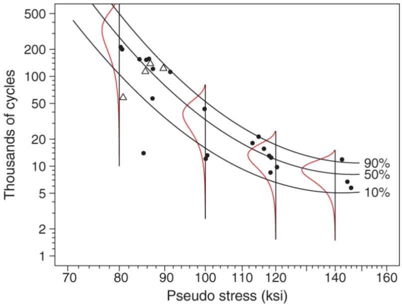
Methods of Acceleration

- Three different methods of accelerating a reliability test:
  1. Increase the **use-rate** of the product.
  2. Increase the **aging-rate** of the product.
  3. Increase the **level of stress** under which test units operate.
- Use a physical/chemical or empirical model relating degradation or lifetime at use condition.

1. Introduction
2. Example

Superalloy Data

Pseudostress	Thousands of Cycles	Status	Pseudostress	Thousands of Cycles	Status
80.3	211.629	F	99.8	43.331	F
80.6	200.027	F	100.1	12.076	F
80.8	57.923	C	100.5	13.181	F
84.3	155.000	F	113.0	18.067	F
85.2	13.949	F	114.8	21.300	F
85.6	112.968	C	116.4	15.616	F
85.8	152.680	F	118.0	13.030	F
86.4	156.725	F	118.4	8.489	F
86.7	138.114	C	118.6	12.434	F
87.2	56.723	F	120.4	9.750	F
87.3	121.075	F	142.5	11.865	F
89.7	122.372	C	144.5	6.705	F
91.3	112.002	F	145.9	5.733	F



$$\Rightarrow \quad T_{\text{Stress}} \sim \mathit{Weibull}(\mu_{\text{Stress}}, \sigma_{\text{Stress}})$$

Fitting Model 2

$$\mu = \beta_0^{[\mu]} + \beta_1^{[\mu]} \log x + \beta_2^{[\mu]} (\log x)^2, \text{ and } \log \sigma = \beta_0^{[\sigma]} + \beta_1^{[\sigma]} \log x.$$

	Parameter	ML estimate	Standard error	Lower	Upper
Model 1	β_0	217.61	62.1	95.9	339.3
	β_1	−85.52	26.53	−137.5	−33.53
	β_2	8.48	2.83	2.93	14.03
	σ	0.375	0.067	0.26	0.53
Model 2	$\beta_0^{[\mu]}$	243.2	58.12	129.3	357.1
	$\beta_1^{[\mu]}$	−96.54	24.73	−145.0	−48.07
	$\beta_2^{[\mu]}$	9.67	2.63	4.52	14.8
	$\beta_0^{[\sigma]}$	4.47	4.17	−3.71	12.6
	$\beta_1^{[\sigma]}$	−1.18	0.89	−2.93	0.58

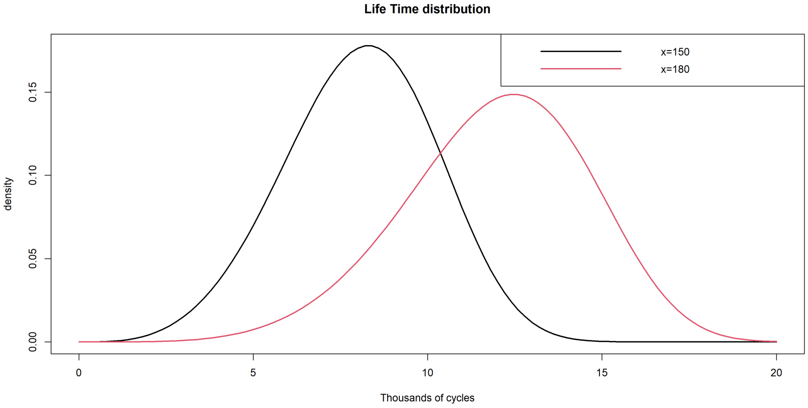
Question

17.10 Consider the model used in Example 17.9 and the corresponding ML estimates for model 2 in Table 17.2.

a. Show that it is possible to have $t_p(x_1) < t_p(x_2)$ when $x_1 < x_2$.

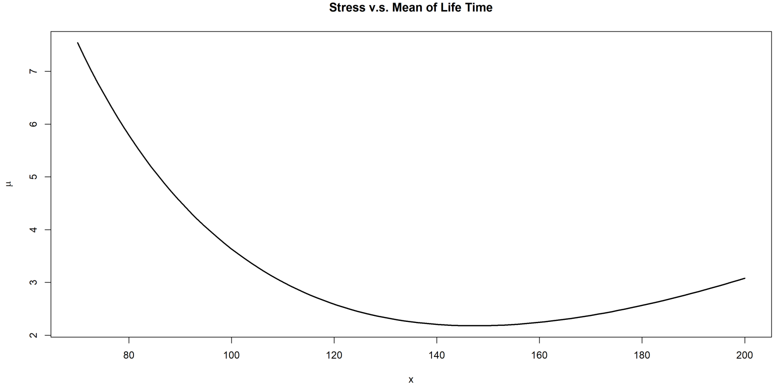
b. Explain why the relationship in part (a) is physically unreasonable.

Weibull PDF under different Stress



Regression Model for Mean μ

$$\hat{\mu} = \hat{\beta}_0^{[\mu]} + \hat{\beta}_1^{[\mu]} \log x + \hat{\beta}_2^{[\mu]} (\log x)^2$$



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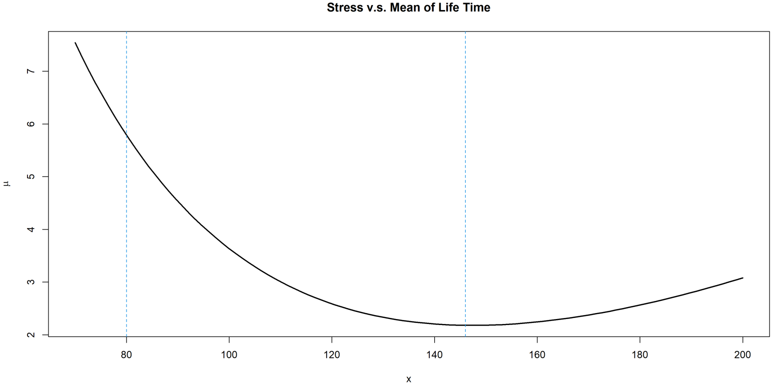

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