1. Use times to failure for high speed turbine engine bearings made from two different compounds.

(a) Make normal plots for the lifetimes and log-lifetimes.

i. We do not expect "constant variance/normal distribution" ordinary statistical methods to be reliable in the analysis of these data because it seems compound 2 cannot be described with a normal distribution.

![Normal Q-Q Plot for compound 1](image1)

![Normal Q-Q Plot for compound 2](image2)

ii. It is still not appropriate to use "constant variance/normal distribution" ordinary statistical methods in the analysis of the log lifetimes.

![Normal Q-Q Plot for log(compound 1)](image3)

![Normal Q-Q Plot for log(compound 2)](image4)

iii. > median(compound2)
   [1] 4.68
   > B <- 10000
   > comp2boot.non <- bootstrap(compound2,B,"median")
   > round(sqrt(var(comp2boot.non)),3)
   [1] 0.831 # standard error for the sample median

(b) > kl <- floor((B+1)*.025)
   > ku <- B+1-kl
   > sortcomp2boot.non <- sort(comp2boot.non)
   > c(sortcomp2boot.non[kl],sortcomp2boot.non[ku])
   [1] 4.395 7.575 # 95% percentile bootstrap confidence interval for the median of F

(c) The ML estimates of the shape and scale parameters of a Weibull distribution are 2.32 and 6.86, respectively.

> fit2 <- fitdistr(compound2,"weibull")
> fit2
   shape   scale
   2.3200021  6.8594860
   (0.5243508) (0.9958011)
A parametric bootstrap standard error for the sample median is 1.073 millions of cycles and a parametric 95% (unadjusted) percentile bootstrap confidence interval for the median of F is (3.897, 8.063). The parametric standard error is larger than the non-parametric standard error. Therefore, the parametric confidence interval is wider than the non-parametric confidence interval.

\[
\frac{1}{2/(\theta)\sqrt{n}} = 1.169
\]

is similar to the parametric bootstrap standard error.

\[
\frac{1}{(2*dweibull(median(compound2),fit2$estimate[1],fit2$estimate[2])*sqrt(10))}
\]

is clearly non-zero.

A 95% percentile confidence interval for the difference in underlying median lifetimes is (−10.54, −0.66). This difference is clearly non-zero.

2. See Prof. Vardeman’s solution posted on the 2003 Stat 511 Web page.