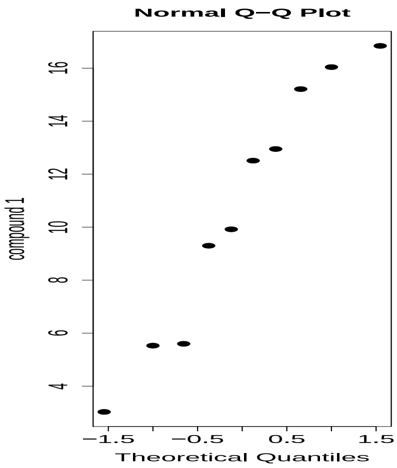
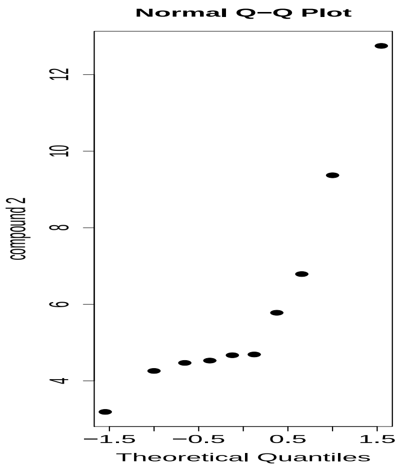
1. Use times to failure for high speed turbine engine bearings made from two different compounds.

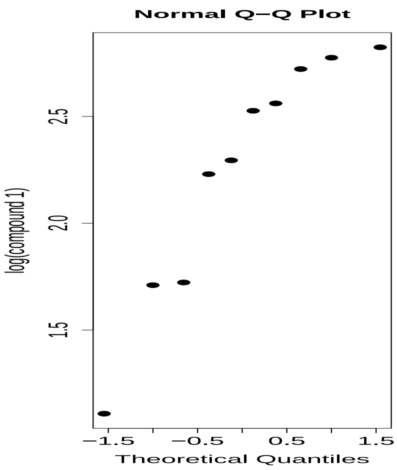
   (a) Make normal plots for the lifetimes and log-lifetimes.

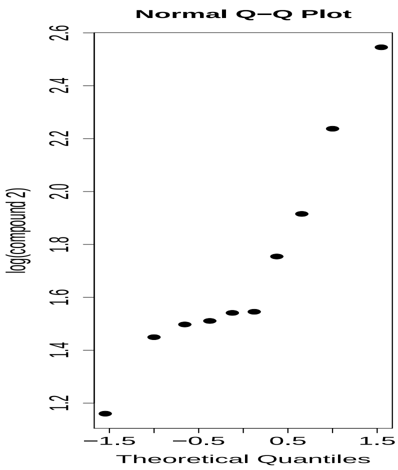
      i. We do not expect "constant variance/normal distribution" ordinary statistical methods to be reliable in the analysis of these data because it seems `compound 2` cannot be described with a normal distribution.




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




      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 inteval 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.

```
> comp2boot.Wei <- Wboot(10,B,"median",fit2$estimate[1],fit2$estimate[2])
> round(sqrt(var(comp2boot.Wei)),3)
[1] 1.073
> sortcomp2boot.Wei <- sort(comp2boot.Wei)
> round(c(sortcomp2boot.Wei[kl],sortcomp2boot.Wei[ku]),3)
[1] 3.897 8.063
```

(d) $\frac{1}{2f(\hat{\theta})\sqrt{n}} = 1.169$ is similar to the parametric bootstrap standard error.

```
> 1/(2*dweibull(median(compound2),fit2$estimate[1],fit2$estimate[2])*sqrt(10))
[1] 1.169048
```

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

```
> comp1boot.non <- bootstrap(compound1,B,"median")
> diff.non <- comp2boot.non-comp1boot.non
> c(sort(diff.non)[kl],sort(diff.non)[ku])
[1] -10.54  -0.66
```

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