Exercise – Nonlinear Models

Answer the following questions with R code by creating (*and editing if you make a mistake*) an R script and iteratively running the code in RStudio.

1. Load the data in the **LakeTroutALTER.csv** file into a data frame in R.

```
> setwd("C:/aaaWork/Web/fishR/courses/Vermont2014/CourseMaterial/Exercises")
> lkt <- read.csv("Data/LakeTroutALTER.csv")
> str(lkt)
'data.frame': 86 obs. of  8 variables:
 $ id    : int  18 512 307 52 84 37 80 36 17 59 ...
 $ tl    : int  225 247 256 268 285 288 295 324 328 330 ...
 $ fl    : int  202 226 235 241 262 265 270 295 297 299 ...
 $ sl    : int  185 212 209 228 240 244 243 273 278 280 ...
 $ w     : int  76 138 120 170 185 182 205 275 285 297 ...
 $ otorad: num  0.84 0.879 0.843 0.944 0.99 ...
 $ age   : int  8 6 6 9 7 9 7 10 7 10 ...
 $ sex   : Factor w/ 2 levels "F","M": 1 1 1 1 1 1 1 1 1 1 ...
```

2. Compute point estimates for the three parameters of a "traditional" von Bertalanffy growth model.

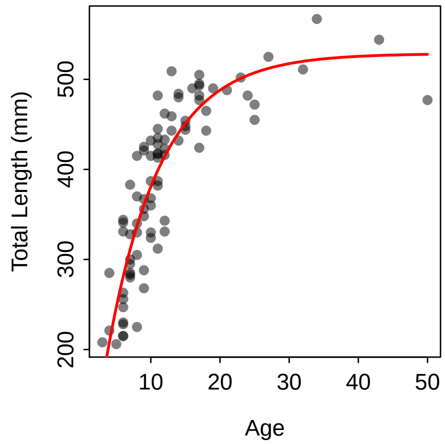
```
> svb1 <- vbStarts(tl~age,data=lkt,type="typical")
> fit1 <- nls(tl~Linf*(1-exp(-K*(age-t0))),data=lkt,start=svb1)
> ( cf <- coef(fit1) )
    Linf        K       t0
528.6072   0.1292   0.1329
```

3. Compute confidence intervals, using both the profile-likelihood and bootstrap methods, for L_∞ and K. Comment on the difference in intervals between the two methods.

```
> confint(fit1)                       # profile LH method
Waiting for profiling to be done...
          2.5%   97.5%
Linf 497.60635 566.795
K      0.09685   0.167
t0    -1.57094   1.319
> boot1 <- nlsBoot(fit1,niter=200)    # bootstrap method
Warning:  The fit did not converge 1 times during bootstrapping
> confint(boot1)
       95% LCI  95% UCI
Linf 493.00530 565.3455
K      0.09522   0.1695
t0    -1.59689   1.4324
```

4. Construct a plot of length versus age with the best-fit von Bertalanffy growth model superimposed.

```
> plot(tl~age,data=lkt,xlab="Age",ylab="Total Length (mm)",pch=16,col=rgb(0,0,0,1/2))
> curve(cf["Linf"]*(1-exp(-cf["K"]*(x-cf["t0"]))),
       from=3,to=50,n=500,lwd=2,col="red",add=TRUE)
```

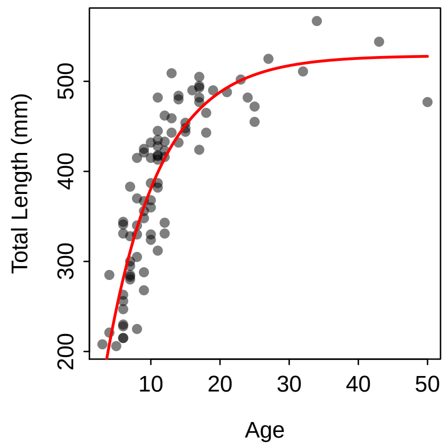


5. Predict the length, with 95% confidence interval, of an age-20 lake trout.

```
> age0 <- 20
> predict(fit1, data.frame(age=age0))

[1] 488

> ests1 <- boot1$coefboot
> pv <- ests1[,"Linf"]*(1-exp(-ests1[,"K"]*(age0-ests1[,"t0"])))
> quantile(pv,c(0.025,0.975))

 2.5% 97.5%
470.4 502.5
```

6. *If time permits ...* repeat the analysis above but using the Gallucci and Quinn parameterization of the VBGM.

```
> svb2 <- vbStarts(tl~age,data=lkt,type="GallucciQuinn")
> fit2 <- nls(tl~omega/K*(1-exp(-K*(age-t0))),data=lkt,start=svb2)
> ( cf <- coef(fit2) )
  omega       K      t0
68.2737  0.1292  0.1329
> confint(fit2)                      # profile LH method
Waiting for profiling to be done...
          2.5%  97.5%
omega 54.12841 84.214
K      0.09685  0.167
t0    -1.57094  1.319
> boot2 <- nlsBoot(fit2,niter=200)   # bootstrap method
Warning:  The fit did not converge 1 times during bootstrapping
> confint(boot2)
       95% LCI 95% UCI
omega 52.32675  85.488
K      0.09308   0.170
t0    -1.85913   1.366
> plot(tl~age,data=lkt,xlab="Age",ylab="Total Length (mm)",pch=16,col=rgb(0,0,0,1/2))
> curve(cf["omega"]/cf["K"]*(1-exp(-cf["K"]*(x-cf["t0"]))),
       from=3,to=50,n=500,lwd=2,col="red",add=TRUE)
> age0 <- 20
> predict(fit2, data.frame(age=age0))
[1] 488
> ests2 <- boot2$coefboot
> pv <- ests2[,"omega"]/ests2[,"K"]*(1-exp(-ests2[,"K"]*(age0-ests2[,"t0"])))
> quantile(pv,c(0.025,0.975))
 2.5% 97.5%
471.5 503.2
```



Total Length (mm)
200
300
400
500
10
20
30
40
50
Age