R Handout - Nonlinear Models

Dr. Derek Ogle
Northland College

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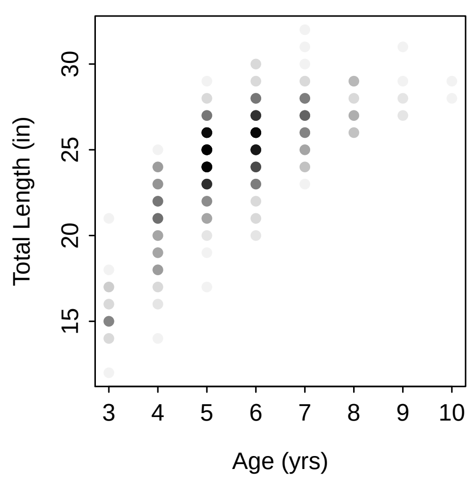
Preliminaries

```
> library(FSA)      # for Subset(), vbModels(), vbStarts(), vbFuns(), confint()
> library(nlstools) # for nlsBoot()
```

```
> setwd("C:/aaaWork/Web/fishR/courses/Vermont2014/CourseMaterial/") # Derek's Computer
> d <- read.csv("Data/TroutBR.csv",header=TRUE)
> str(d)

'data.frame': 851 obs. of  3 variables:
 $ tl     : int  16 16 17 17 17 17 17 17 17 17 ...
 $ age    : int  4 4 2 3 3 3 3 3 3 4 ...
 $ species: Factor w/ 2 levels "Brown","Rainbow": 1 1 1 1 1 1 1 1 1 1 ...

> rbt <- Subset(d,species=="Rainbow")
> str(rbt)

'data.frame': 627 obs. of  3 variables:
 $ tl     : int  12 14 14 14 14 15 15 15 15 15 ...
 $ age    : int  3 3 3 3 4 3 3 3 3 3 ...
 $ species: Factor w/ 1 level "Rainbow": 1 1 1 1 1 1 1 1 1 1 ...
```

```
> # Declare some constants
> xlbl <- "Age (yrs)"
> ylbl <- "Total Length (in)"
> clr <- rgb(0,0,0,1/20)
```

```
> plot(tl~age,data=rbt,xlab=xlbl,ylab=ylbl,pch=16,col=clr)
```



Fit Typical Model

```
> vbModels()
```

FSA von Bertalanffy Parametrizations

Original: $E(L_t) = L_\infty - (L_\infty - L_0)\, e^{-Kt}$

Typical: $E(L_t) = L_\infty\left(1 - e^{-K(t - t_0)}\right)$

GallucciQuinn: $E(L_t) = \frac{\omega}{K}\left(1 - e^{-K(t - t_0)}\right)$

Mooij: $E(L_t) = L_\infty - (L_\infty - L_0)\, e^{-\frac{\omega}{L_\infty}t}$

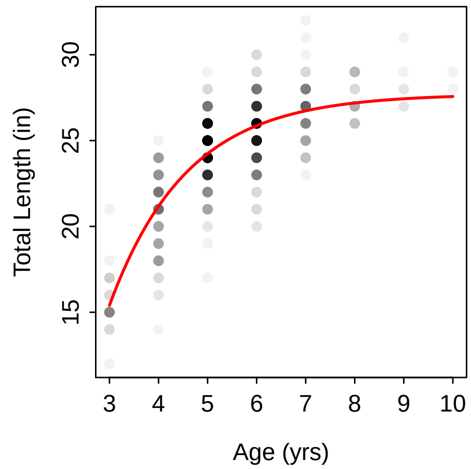
Schnute: $E(L_t) = L_1 + (L_2 - L_1)\,\frac{1 - e^{-K(t - t_1)}}{1 - e^{-K(t_2 - t_1)}}$

Francis: $E(L_t) = L_1 + (L_3 - L_1)\,\frac{1 - r^{2\frac{t - t_1}{t_3 - t_1}}}{1 - r^2}$

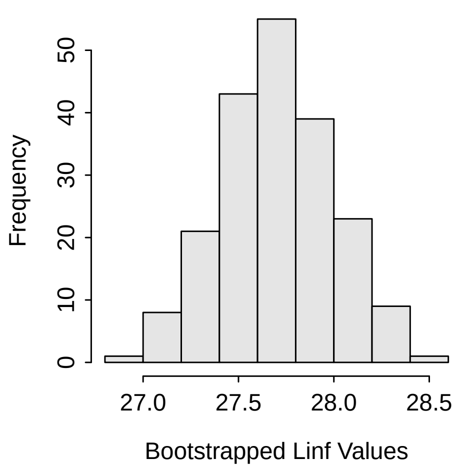
where $r = \frac{L_3 - L_2}{L_2 - L_1}$

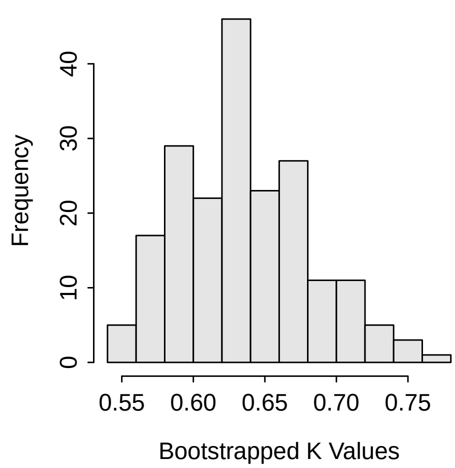
```
> ( svb1 <- vbStarts(tl~age,data=rbt,type="typical") )
$Linf
[1] 28.67

$K
[1] 0.5242

$t0
[1] -1.429

> fit1 <- nls(tl~Linf*(1-exp(-K*(age-t0))),data=rbt,start=svb1)
> summary(fit1)

Formula: tl ~ Linf * (1 - exp(-K * (age - t0)))

Parameters:
     Estimate Std. Error t value Pr(>|t|)
Linf  27.7118     0.2838    97.6   <2e-16
K      0.6324     0.0425    14.9   <2e-16
t0     1.7169     0.1016    16.9   <2e-16

Residual standard error: 1.78 on 624 degrees of freedom

Number of iterations to convergence: 5
Achieved convergence tolerance: 5.38e-08

> confint(fit1)
Waiting for profiling to be done...
       2.5%   97.5%
Linf 27.192 28.3280
K     0.550  0.7192
t0    1.493  1.8999
```

```
> ( cf <- coef(fit1) )

   Linf       K      t0
27.7118  0.6324  1.7169

> plot(tl~age,data=rbt,xlab=xlbl,ylab=ylbl,pch=16,col=clr)
> curve(cf["Linf"]*(1-exp(-cf["K"]*(x-cf["t0"]))),
        from=3,to=10,n=500,lwd=2,col="red",add=TRUE)
```

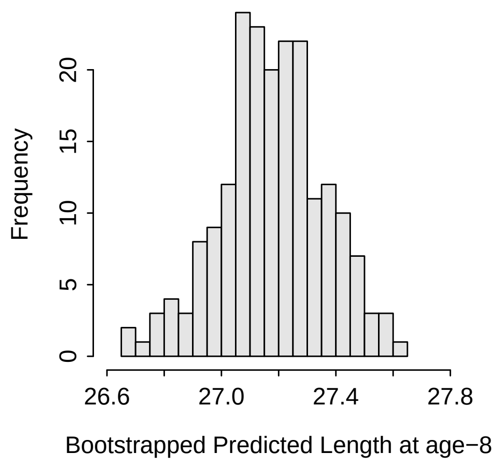



```
> boot1 <- nlsBoot(fit1,niter=200)    # niter should be nearer 1000
> ests1 <- boot1$coefboot
> ests1[1:5,]   # first five rows

      Linf      K    t0
[1,] 27.72 0.6334 1.743
[2,] 28.19 0.5566 1.522
[3,] 28.27 0.5645 1.591
[4,] 27.84 0.6338 1.752
[5,] 27.69 0.6158 1.670

> hist(~ests1[,"Linf"],xlab="Bootstrapped Linf Values")
> hist(~ests1[,"K"],xlab="Bootstrapped K Values")
```





```
> confint(boot1)
     95% LCI 95% UCI
Linf 27.1020 28.2683
K     0.5625  0.7303
t0    1.5242  1.9057
>
> predict(fit1, data.frame(age=8))
[1] 27.19
> pv <- ests1[,"Linf"]*(1-exp(-ests1[,"K"]*(8-ests1[,"t0"])))
> hist(~pv,breaks=20,xlim=c(26.6,27.8),xlab="Bootstrapped Predicted Length at age-8")
```




```
> quantile(pv,c(0.025,0.975))
 2.5% 97.5%
26.79 27.52
```