Fitting a von Bertalanffy Growth Function

Derek H. Ogle, Northland College

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Preliminaries

```
> library(FSA)                     # for headtail(), filterD(), vbModels(), vbStart(), vbFuns()
> library(nlstools)                # for nlsBoot()
```

Loading the Data and Some Preparations

```
> d <- read.csv("data/TroutBR.csv",header=TRUE)
> rbt <- filterD(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 ...

> xlbl <- "Age (yrs)"
> ylbl <- "Total Length (in)"
> clr <- rgb(0,0,0,0.05)
```

What Parameterizations are Available in FSA?

```
> vbModels()
```

FSA von Bertalanffy Parameterizations

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

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

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

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

Weisberg: $E(L_t) = L_\infty\left(1 - e^{-\frac{\log(2)}{(K_0 - t_0)}(t - t_0)}\right)$

Schnute: $E(L_t) = L_1 + (L_3 - L_1)\frac{1 - e^{-K(t - t_1)}}{1 - e^{-K(t_3 - t_1)}}$

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

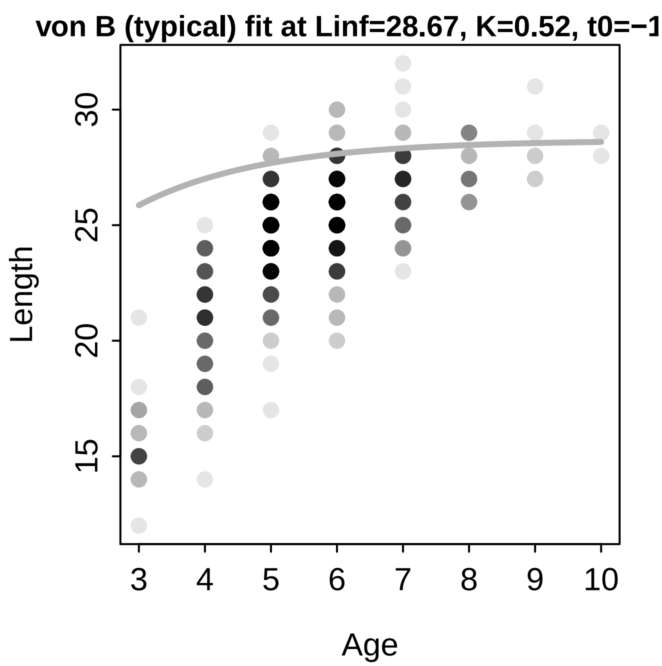
Fit Typical VBGF

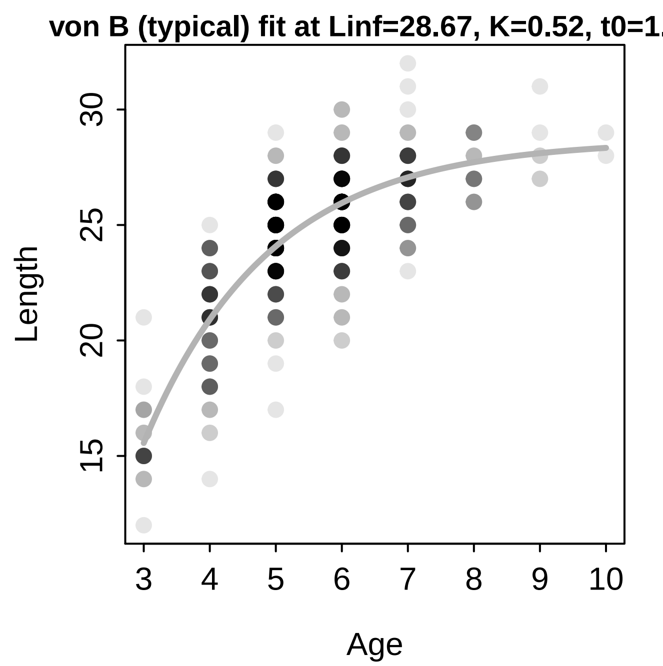
Declare a Function

```
> vb <- vbFuns("typical")
> vb
function(t,Linf,K=NULL,t0=NULL) {
  if (length(Linf)==3) { K <- Linf[[2]]
                         t0 <- Linf[[3]]
                         Linf <- Linf[[1]] }
  Linf*(1-exp(-K*(t-t0)))
}
<environment: 0x090276b0>
```

Find Starting Values

```
> svb.bad <- vbStarts(tl~age,data=rbt,type="typical",plot=TRUE)             # Left
> svb <- vbStarts(tl~age,data=rbt,type="typical",meth0="yngAge",plot=TRUE)  # Right
> unlist(svb)   # unlist() only to save space
      Linf          K         t0
28.6732137  0.5242049  1.5075626
```






```
> # Dynamically approximately fit the function -- Can't be shown in a handout
> vbStarts(tl~age,data=rbt,type="typical",dynamicPlot=TRUE)
> svb2 <- list(Linf=28.7,K=0.52,t0=1.62)
```

Fit the Model

```
> fit1 <- nls(tl~vb(age,Linf,K,t0),data=rbt,start=svb)
> summary(fit1)

Formula: tl ~ vb(age, Linf, K, t0)

Parameters:
     Estimate Std. Error t value Pr(>|t|)
Linf 27.71191    0.28383   97.64   <2e-16
K     0.63242    0.04248   14.89   <2e-16
t0    1.71686    0.10159   16.90   <2e-16

Residual standard error: 1.775 on 624 degrees of freedom

Number of iterations to convergence: 3
Achieved convergence tolerance: 9.636e-06

> ( cf <- coef(fit1) )
      Linf          K         t0
27.7119085  0.6324231  1.7168636

> confint(fit1)
Waiting for profiling to be done...
           2.5%      97.5%
Linf 27.1916077 28.3279785
K     0.5499956  0.7192266
t0    1.4930214  1.8999245

> boot1 <- nlsBoot(fit1,niter=200)   # niter should be nearer 1000
> confint(boot1)
        95% LCI    95% UCI
Linf 27.1797618 28.2733869
K     0.5609374  0.7367008
t0    1.5038998  1.9100696
```

Make Predictions

```
> ageX <- 8
> predict(fit1,data.frame(age=ageX))
[1] 27.19077

> headtail(boot1$coefboot)
           Linf         K       t0
[1,]   27.42327 0.6538666 1.739262
[2,]   27.37897 0.6884866 1.808244
[3,]   27.83712 0.6171078 1.663210
[198,] 27.40817 0.6956157 1.877872
[199,] 27.30673 0.6660497 1.718881
[200,] 27.70402 0.6178604 1.659942

> pv <- apply(boot1$coefboot,MARGIN=1,FUN=vb,t=ageX)
> quantile(pv,c(0.025,0.975))
    2.5%    97.5%
26.83585 27.54044
```

Visualize the Fit

```
> plot(tl~age,data=rbt,xlab=xlbl,ylab=ylbl,pch=16,col=clr)
> curve(vb(x,cf),from=3,to=10,n=500,lwd=2,col="red",add=TRUE)
```