Simulation Modelling with Age length Keys using ALKr

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Abstract

The **ALKr**

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1. Introduction

The **ALKr** packge is designed to be used for calculating Age-Length Keys from incomplete data, i.e. where aged data are not available for every year or strata. It contains several methods i.e. `gascuel, hoenig_heisey, inverse_ALK` and `kimura_chikuni`. In this document we show how to simulate data for use by these functions to evluate their performance as part of stock assessment procedures.

We use the packages **ggplot2**, **plyr** and **FLR** for plotting, data manipulation and stock assessment.

2. Methods

There are 3 methods for simulating Age Length Keys i.e. to

- `alk` generate a perfect ALK
- `sampleAlk` randomly sample from an existing ALK and
- `randAlk` randomly generate an ALK using Monte Carlo simulation

and 2 methods for creating random length frequency distributions (i.e. catch at size) and frequency distributions, i.e.

- `randFrq` to create a perfect ALK
- `randLfd` to randomly sample from an existing ALK and

`randFrq(n, object)`

2.1. Data

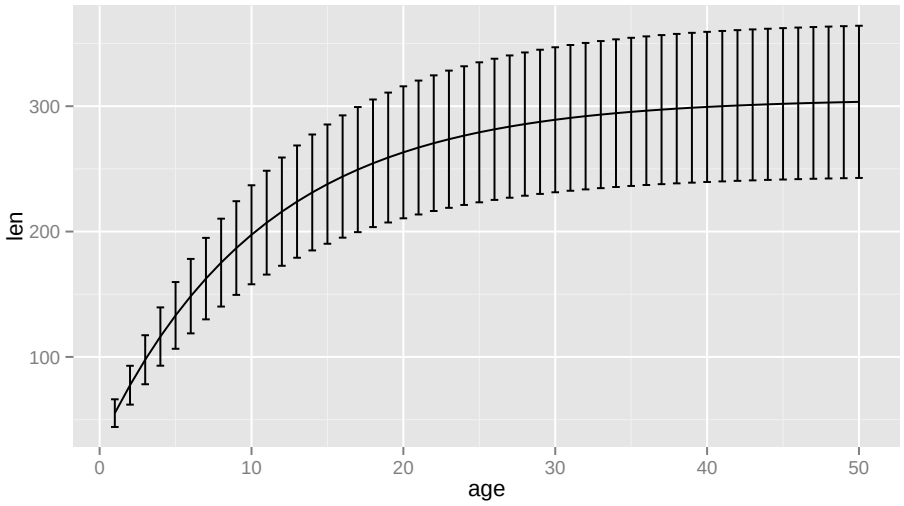
Data are generated based on the Von Bertalanffy growth equation and the catch equation.

$$l = L_{\text{inf}}(1.0 - e^{-Ka-t_0})$$

$$c_{a+1} = c_a \frac{F_a}{F_a+M_a}(1 - e^{-F_a-M_a})$$

```
> library(ALKr)
> par =c(linf=318.85*.96,k=0.093,t0=-0.97-.16667,a=1.96e-8,b=3.0092)
> dat=data.frame(len=par["linf"]*(1.0-exp(-par["k"]*(1:50-par["t0"]))),
+                age=1:50)
> dat$sd=dat$len*.1

> p=ggplot(dat)+
+   geom_line(aes(age,len))+
+   geom_errorbar(aes(age,ymin=len-sd*2,ymax=len+sd*2),width=.5)
> print(p)
```



Add mortality vectors

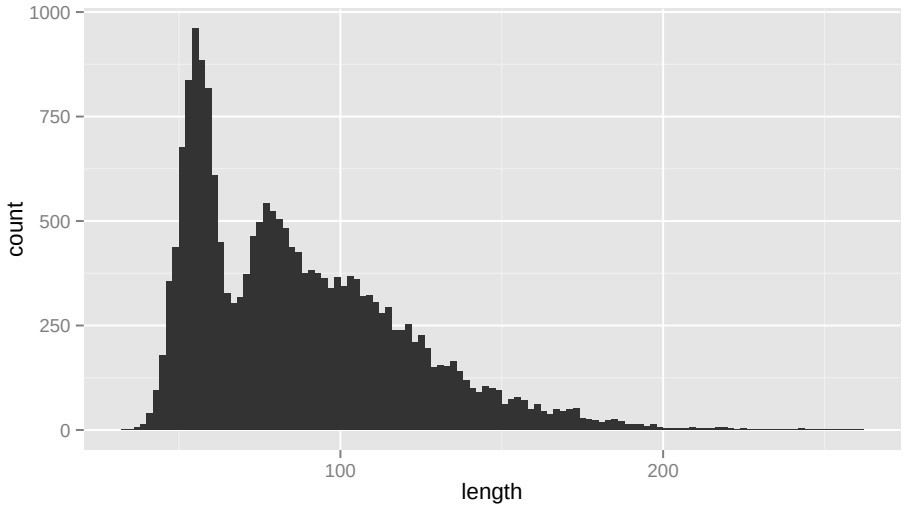
```
> dat=transform(dat, m  =rep(0.2,length(age)),
+                    sel=c(rep(0.2,3),rep(1,length(age)-3)))
```

Generate numbers and catch-at-age

```
> dat=transform(dat, f=sel*.5,
+                    z=sel*.5+m)
> naa=with(dat,10000*exp(-cumsum(m+f)))
> caa=with(dat,naa*f/z*exp(-z))
```

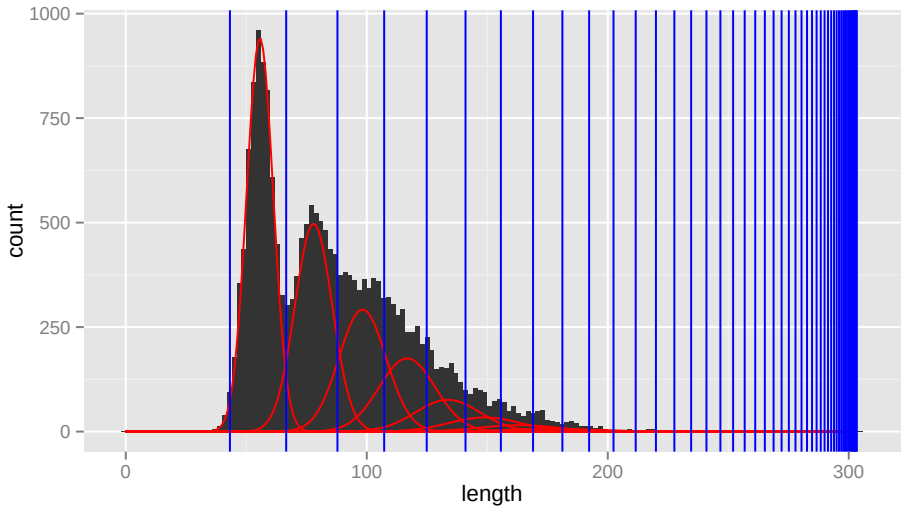
2.2. Length Frequency Data

```
> lfd=randLfd(20000,caa,dat$len,dat$sd)
> p=ggplot(data.frame(freq  =lfd,
+                 length=as.numeric(substr(names(lfd),2,regexpr(",",names(lfd))-1))))+
+   geom_histogram(aes(length,weight=freq),binwidth=2)
> print(p)
```



2.3. Age Length Key

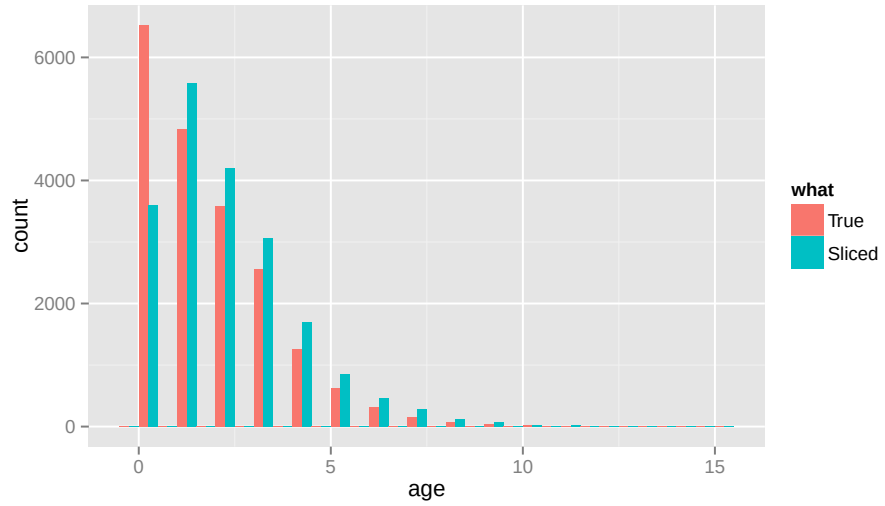
```
> al=sweep(alk(seq(0,300,1),dat$len,dat$sd),1,caa,"*")
> al=melt(40000*al/sum(al))
> laa=par["linf"]*(1.0-exp(-par["k"]*(dat$age-0.5-par["t0"])))
> print(p+geom_line(aes(len,value,group=age),data=al,col="red")+
+   theme(legend.position="none")+
+   geom_vline(aes(xintercept=laa),data=data.frame(laa=laa),col="blue"))
>
```



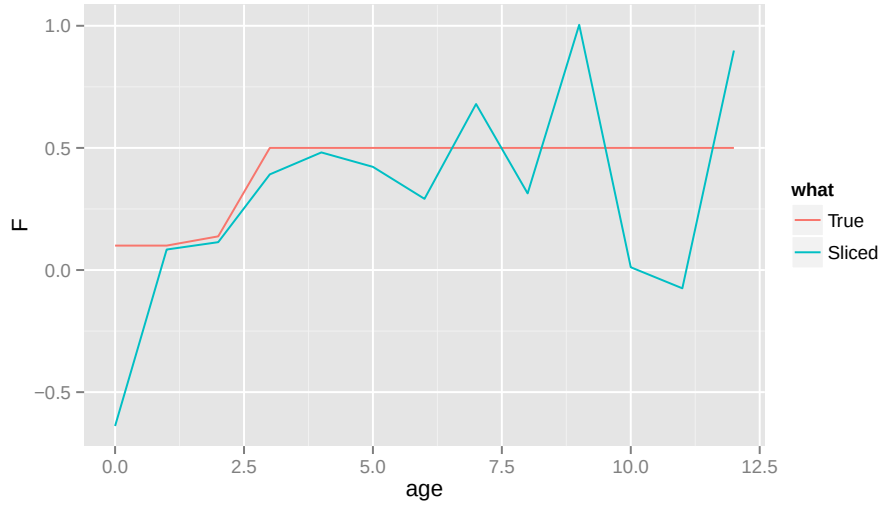
3. Examples

3.1. Age Slicing

```
> names(lfd)=substr(names(lfd),2,regexpr(",",names(lfd))-1)
> res=age_slicing(fi=lfd, vb_params =c(t0=-0.97-.16667-.5,k=0.093,linf=318.85*.96),
+                         age_limits=c(0,15))
> caa[16]=sum(caa[16:50])
> caa=caa[0:16]
> caa=sum(res,na.rm=T)*caa/sum(caa)
> age=rbind(data.frame(what="True",  caa=caa[1:16],age=0:15),
+           data.frame(what="Sliced",caa=res,      age=0:15))
> print(ggplot(age)+geom_histogram(aes(age,weight=caa,fill=what,group=what),data=age,posit
```




```
> f=rbind(data.frame(what="True",  F=-log(caa[2:14]/caa[1:13])-.2,age=0:12),
+         data.frame(what="Sliced",F=-log(res[2:14]/res[1:13])-.2,age=0:12))
> print(ggplot(age)+geom_line(aes(age,F,group=what,col=what),data=f))
```



3.2. Monte Carlo

4. References

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