Basic formulae and data analysis strategies for mixed effects models in R

a)nlme library

```
library(nlme)
library(MASS)
library(pgirmess)

model1=lme(y~a*b,
      random=~1|c/d,
      method="ML",
      subset=(a<1&c!="f"))

summary(model1)

model2=stepAIC(model1)
anova(model2,test="F")
qqnorm(model2,~resid(.)|c)
plot(model2)
plot(model2, resid(., type = "p") ~ fitted(.)|c, abline = 0)

model3<-update(model2,weights=varPower(form=~b))
model4=update(model3,~.-c)
anova(model3,model4)
AIC(model3,model4)
```

Variance components analysis:

```
model5=lme(subject~1,random=~1|a/b/c/d/e) #not method="ML" here
summary(model5)
sds=c(....)
vars=sds^2
100*vars/sum(vars) # gives the variance components individuall
```

Factor level reduction: Condense factor levels, e.g.

```
newfac=factor(paste(fac1,fac2,sep=""))
```

Temporal pseudoreplication

For example: growth of six replicate trees measured at five occasions

```
model6=lme(y~a+b,random=~time|individual)
newdata=groupedData(y~time|individual,outer=~a,newdata)
plot(newdata)
plot(newdata,outer=T)
```

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for comparison: simple ANOVA for just one timepoint:

```
model6a=aov(y~a+b,subset=time=="1")
```

Time series analysis in mixed-effects models

You usually start with a given model and analyse its autocorrelation function, then take this autocorrelation into account using the command "correlation=...":

```
model7=lme(y~a+b,random)~1|subject)
```

now calculate and plot the empirical autocorrelation structure of the residuals of the model:

```
plot(ACF(model7),alpha=0.05)
model8=update(model7,correlation=corARMA(q=2))
```
or:
```
model8=update(model7,correlation=corAR1())

plot(model8,resid(.,type="p"~fitted(.)|subject)
qqnorm(model8,~resid(.)|subject)
```

Regression with random effects:

```
model9=lmList(y~a|b,data=data.2)
model10=y~a,random=~1|c,method="ML")
```

b) lme4 library

This allows the inclusion of non-normal errors into the model - the corresponding models are therefore called "generalized linear mixed-effects models". The lme4 library is still under development, and P-values are not always given.

```
library(lme4)

model1a=
lmer(y~a*b+(1|c/d),method="ML",subset=(a<1&c!="f"),family="poisson")
```

Variance components analysis in lme4

```
model5=lmer(subject~1+(1|a/b/c/d/e))

summary(model5)
```

alternatively, in case there is a fixed effect you are interested in:

```
model6= lmer(subject~a+(1|a/b/c/d/e))
```

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