Exercice 1. Effect of sleep deprivation on the cognitive performance of drivers.

Several truck drivers were subjected to only 3 hours of sleep a night for several consecutive nights. Their cognitive performance (Reaction) was assessed each day using the average reaction time (in ms) Does the reaction time vary over time?

First install the library lm4 and load the sleepstudy data set

```
> library(lme4)
> data("sleepstudy")
```

This dataset contains 3 variables ("Reaction", "Days", and "Subject"). "Reaction" is the reaction time measures, "Days" is the day when the measurement was taken, counting from the first day without sleep deprivation (Day=0). "Subject" is a unique identification number for each driver

```
> colnames(sleepstudy)
```

You can graph the number of days in sleep deprivation and reaction time, but this representation does not consider intra-subject variability. In each subject the value observed at time t depends on the values observed before.

```
> plot(sleepstudy$Days,sleepstudy$Reaction)
```

We can represent this intra-observer dependence if we join the dots for each subject. Therefore, each line represents a driver.

```
> lines(sleepstudy$Days,sleepstudy$Reaction)
```

We can also represent this intra-observer dependence with colors. Therefore, each color represents a driver.

```
> (colour_plot <- ggplot(sleepstudy , aes(x = Days, y = Reaction , colour = Subject)) +
geom_point(size = 2) + theme_classic() + theme(legend.position = "none"))
```

We can look at the performance of each individual driver

```
> library(ggplot2)
> (split_plot <- ggplot(aes(Days, Reaction), data = sleepstudy) +
+       geom_point() +
+       facet_wrap(~ Subject) +
+       xlab("Days") +
+    ylab("Reaction time"))
```

Now we can build the LINEAR MIXED MODEL:

```
> model <- lmer(Reaction ~ Days + (Days | Subject), sleepstudy)
> summary(model)
```

FIXED EFFECTS:
LMM shows us that the average reaction time at start (251.4 ms) and the average increase of reaction time due to sleep deprivation (10.5ms/day).

RANDOM EFFECTS:
We can observe that the variance of subject/driver (612.10) at the beginning and the variance of subjects reaction to sleep deprivation (35.07) are clearly important: they explain a lot of variation.

(612.10 + 35.07) / (612.10 + 35.07 + 654.94) = 0.50

So, the subjects' differences explain 50% of the variance that's left over after the variance explained by our fixed effects (Days in sleep deprivation).

```
> ranef(model)
```

Subject number 309 had a better reaction time at the start and was less affected by sleep deprivation
Subject number 337 was slower to start and was more affected by sleep deprivation.
Subject number 370 was faster at the start and was more affected by sleep deprivation.

Exercice 2. Effect of sleep deprivation on the cognitive performance of drivers.

We have 578 rows and 4 columns from a study on the effect of diet on chicken growth.

The chicken weight (weight) at baseline (Time = 0) and several days later (Chick) was recorded.

The type of diet (Diet) was also recorded.

Does the type of diet is related with chicken weight gain?

```
plot(ChickWeight$Time, ChickWeight$weight)
lines(ChickWeight$Time, ChickWeight$weight)
library(lme4)
modelogalinhas <- lmer(weight ~ Diet + Diet*Time + Time + (Time | Chick), ChickWeight)
summary(modelogalinhas)

library(ggplot2)
ChickWeight$Diet <- factor(ChickWeight$Diet)
p <- ggplot(data = ChickWeight,aes(x = Time,y = weight))
p + stat_summary(fun.y = 'mean',geom = 'line',aes(group = Diet,colour = Diet)) +
stat_summary(fun.y = 'mean',geom ='point',aes (group = Diet,colour = Diet))
```