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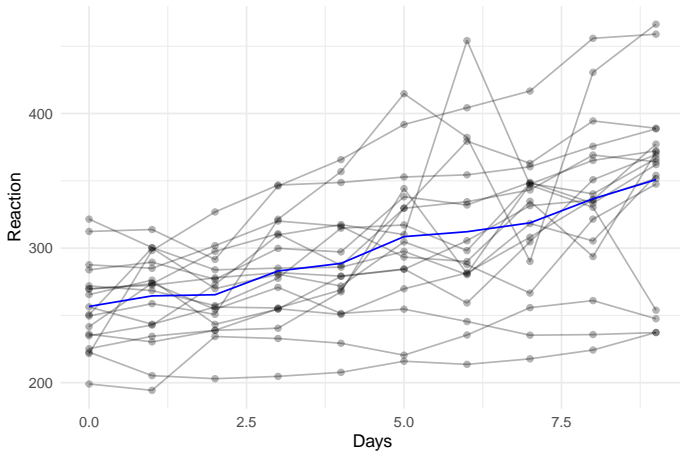
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Motivation: sleepstudy data

- ▶ The average reaction time per day for subjects was evaluated by Gregory et al. (2003) in a sleep deprivation study.
- ▶ On day 0 the subjects had their normal amount of sleep and starting that night they were restricted to 3 hours of sleep per night for 9 days, and the reaction time based on a series of tests was measured on each day for each subject.
- ▶ The data are available at the R package *lme4*.

Motivation: sleepstudy data



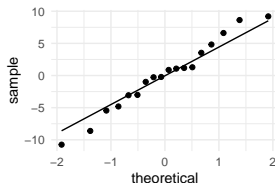
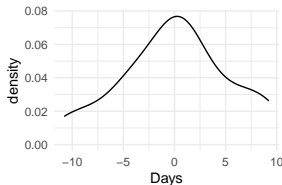
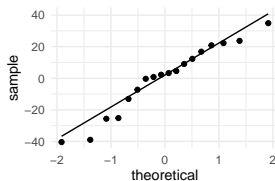
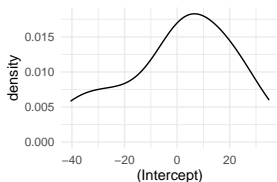
Introduction

- ▶ Bullet 1
- ▶ Bullet 2
- ▶ Bullet 3

Linear mixed models

Fitting a LMM to the sleepstudy dataset

```
fit1 <- lme(Reaction~Days,data=sleepstudy,  
            random=~Days|Subject)
```



Model formulation

Within-subject dependence structures

Tools for model evaluation

The R package *skewlmm*

- ▶ The package *skewlmm* implements an EM-type algorithm in R using S3 class, containing methods for estimating and predicting the SMSN-LMM.
- ▶ It has an user-friendly interface with generic R functions `print`, `summary`, `plot`, `fitted`, `residuals` and `predict` implemented.
- ▶ The main functions in the package are the `smsn.lmm()` and `smn.lmm()` functions, which estimates the parameter of a SMSN-LMM and a SMN-LMM, respectively.

The R package *skewlmm*

- ▶ The basic syntax of these functions is as follows:

```
smsn.lmm(data, formFixed, groupVar, formRandom,  
          depStruct, distr, ...)  
smn.lmm(data, formFixed, groupVar, formRandom,  
          depStruct, distr, ...)
```

where

- ▶ `data`: A data frame containing all the variables to be used in the model.
- ▶ `formFixed`: A two-sided linear formula object describing the fixed effects part of the model.
- ▶ `groupVar`: A character containing the name of the variable which represents the subjects or groups in data.

- ▶ `formRandom`: A one-sided linear formula object describing the random effects part of the model.
- ▶ `depStruct`: A character indicating which dependence structure should be used.
- ▶ `distr`: A character indicating which distribution should be used.

References

- ▶ Gregory Belenky, Nancy J. Wesensten, David R. Thorne, Maria L. Thomas, Helen C. Sing, Daniel P. Redmond, Michael B. Russo and Thomas J. Balkin (2003) Patterns of performance degradation and restoration during sleep restriction and subsequent recovery: a sleep dose-response study. *Journal of Sleep Research* 12, 1–12.