

Statistical Analysis of Repeated Measurements Data

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Contents

1	Motivating Data Sets	1
1.1	Motivating Longitudinal Studies	2
1.2	Features of Longitudinal Data	14
1.3	Review of Key Points	26
2	Marginal Models for Continuous Data	27
2.1	Simple Methods	28
2.2	Review of Linear Regression	37
2.3	Marginal Models	46

2.4 Interpretation	52
2.5 Estimation	63
2.6 Fitting Marginal Models in R	69
2.7 Covariance Matrix	73
2.8 Model Building	84
2.9 Hypothesis Testing	87
2.10 Confidence Intervals	111
2.11 Residuals	113
2.12 Review of Key Points	129

3	The Linear Mixed Effects Model	131
3.1	The Linear Mixed Model	132
3.2	Interpretation	138
3.3	Hierarchical vs Marginal	146
3.4	Estimation	155
3.5	Mixed-Effects Models in R	165
3.6	Nested and Crossed Random Effects*	170
3.7	Mixed Models with Correlated Errors	172
3.8	Time-Varying Covariates*	178
3.9	Model Building	188
3.10	Hypothesis Testing	191

3.11 Residuals	192
3.12 Review of Key Points	202

4 Marginal Models for Discrete Data 205

4.1 Review of Generalized Linear Models	206
4.2 Generalized Estimating Equations	219
4.3 Interpretation	227
4.4 Generalized Estimating Equations in R	234
4.5 Working Correlation Matrix	237
4.6 Hypothesis Testing	248
4.7 Review of Key Points	257

5	Mixed Models for Discrete Data	259
5.1	Generalized Linear Mixed Models	260
5.2	Interpretation	262
5.3	Estimation	264
5.4	GLMMs in R	266
5.5	Model Building	268
5.6	Hypothesis Testing	270
5.7	Review of Key Points	272
6	Statistical Analysis with Incomplete Grouped Data	274
6.1	Missing Data in Longitudinal Studies	275

6.2 Missing Data Mechanisms 280

6.3 Analysis with Incomplete Data 295

6.4 Summary 317

6.5 Review of Key Points 319

7 Closing 321

7.1 Concluding Remarks 322

Practicals 326

Practical 1: Marginal Models Continuous 327

Practical 2: Mixed Models Continuous 336

Practical 3: Marginal Models Discrete 345

Practical 4: Mixed Models Discrete	349
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What is this Course About

Grouped data arise in wide range of disciplines

- Typical examples of grouped data
 - ▷ *repeated measurements*: measuring the same outcome multiple times on the same sample unit (e.g., biomarkers in patients)
 - ▷ *multilevel data*: outcomes measured on sample units that are organized in different levels (e.g., patients in medical centers or students in schools)

What is this Course About (cont'd)

- Statistical analysis of grouped data
 - ▷ Features of grouped data
 - ▷ describe their distribution
 - ▷ inference using suitable regression models

Learning Objectives

- Goals: After this course participants will be able to
 - ▷ identify settings in which family of repeated measurements model is required,
 - ▷ construct and fit an appropriate model to the data at hand, and
 - ▷ correctly interpret the obtained results
- Even though the course will be primarily explanatory
 - ▷ emphasis is given on sufficient detail in order for participants to obtain a clear view on the different modeling approaches, and how they should be used in practice

Agenda

- **Chapter 1:** Motivating Data Sets

- ▷ Data sets that we will use throughout the course
- ▷ General repeated measurements settings
- ▷ Research questions

- **Chapter 2:** Marginal Models for Continuous Data

- ▷ Features of repeated measurements data
- ▷ Naive approaches
- ▷ Review linear regression
- ▷ Marginal models

Agenda (cont'd)

- **Chapter 3:** The Linear Mixed Effects Model
 - ▷ Intuition behind mixed models
 - ▷ nested and cross random effects
- **Chapter 4:** Marginal Models for Discrete Data
 - ▷ Review generalized linear models
 - ▷ Generalized estimating equations

Agenda (cont'd)

- **Chapter 5:** Mixed Models for Discrete Data

- ▷ Generalized linear mixed effects models
- ▷ approximations of the integrand & integral
- ▷ interpretation of parameters

- **Chapter 6:** Statistical Analysis with Incomplete Grouped Data

- ▷ Problems with incomplete data
- ▷ Missing data mechanisms
- ▷ Valid inferential approaches

Structure of the Course & Material

- Lectures & software practicals using R
- Material:
 - ▷ Course Notes
 - ▷ R code in soft format
- Within the course notes there are several examples of R and SPSS syntax – these are denoted by the symbols 'R>' and 'SPSS>', respectively

Software Requirements

- The up-to-date version of R and Rstudio; downloadable from
 - ▷ <http://cran.r-project.org/>
 - ▷ <http://www.rstudio.com/>
- Additional required packages
 - ▷ **lme4, MCMCglmm, geepack,**
 - ▷ **MASS, shiny, corrplot**

Software Requirements

- Up-to-date versions of these packages and their dependencies can be installed using the command

```
install.packages(c("shiny", "nlme", "lattice", "lme4",  
                  "MCMCglmm", "geepack", "MASS", "corrplot"),  
                dependencies = TRUE)
```

- Up-to-date version of a modern web browser, e.g.,
 - ▷ Mozilla Firefox (<https://www.mozilla.org/firefox/>)
 - ▷ Google Chrome (<http://www.google.com/chrome/>)

Software Requirements

- A [shiny](#) web app that replicates all analyses in the course including also some additional illustrations
- The app is available on GitHub and can be invoked using the following two-step procedure (assuming internet connection is available)
 1. Start R
 2. Run the command

```
shiny::runGitHub("Repeated_Measurements", "drizopoulos")
```

this will open a new web browser window (or tab) with the app

- Note: in order the app to be functional you should **not** close R

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