TITLE

Frank E Harrell Jr
Division of Biostatistics and Epidemiology
Department of Health Evaluation Sciences
University of Virginia School of Medicine
Box 800717 Charlottesville VA 22908 USA
fharrell@virginia.edu
hesweb1.med.virginia.edu/biostat

MEETING
DATE

Outline

1. ....
    - ....

Outline

1. Introduction
   - motivating examples of linear and non-linear mixed-effects models
   - $x^2 - \sum_{i=1}^{n} \chi^2$
   - a sample of S-PLUS commands for fitting and analyzing mixed-effects models.
2. Grouped data
   - repeated measures, longitudinal data, growth curve data
   - multiply-nested data
   - Data structures, classes, and methods for grouped data in S-PLUS
   - Trellis displays for grouped data

Outline (cont.'d)

3. Linear mixed-effects models
   - brief review of linear models
   - linear mixed-effects (LME) model
   - Multilevel LME models
   - the lme function in S-PLUS
4. Extending the basic LME model
   - modelling the random effects covariance structure
   - variance functions for modelling heteroscedasticity
   - correlation structures: serial, spatial
   - S-PLUS capabilities for extending and customizing the lme function
   - the gls function in S-PLUS

Outline (cont.'d)

5. Nonlinear mixed-effects models

- nonlinear regression model
- starting estimates: self-starting models
- nonlinear mixed-effects (NLME) models
- the nlme function in S-PLUS
- extending the basic NLME model
- using covariates with nlme

Some examples

Orthodont – orthodontic growth data

Distance (in millimeters) between the pituitary and the pterygomaxillary fissure measured every two years for 27 children (16 males, 11 females) from age 8 until age 14. Reported in [1]

```
    distance age Subject  Sex
1       26.0   8     M01 Male
2       25.0  10     M01 Male
3       29.0  12     M01 Male
4       31.0  14     M01 Male
5       21.5   8     M02 Male
6       22.5  10     M02 Male
. . .
104     19.5  14     F10 Female
105     24.5   8     F11 Female
106     25.0  10     F11 Female
107     28.0  12     F11 Female
108     28.0  14     F11 Female
```

- balanced data
- linear growth with time

Figure 1: This is a test. This is only a test.

- similar patterns across individuals, but with different intercepts and slopes [**?**]

References

[1] R. F. Potthoff and S. Roy. A generalized multivariate analysis of variance model useful especially for growth curve problems. *Biometrika*, pages 313–326, 1964.

Abstract

. . . . .