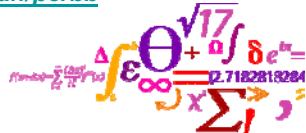


# Intro to mixed models for sensory and consumer data using PanelCheck



Per Bruun Brockhoff, Professor  
DTU Compute,  
Danish Technical University

[www.compute.dtu.dk/staff/perbb](http://www.compute.dtu.dk/staff/perbb)



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# Outline, 09:00-10.30



- Mixed model software tools by DTU group
  - Introduction to linear mixed models
  - From simple to 3-way ANOVA for sensory data

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# Software tools by Sensometrics @DTU: (with linear mixed models, OPEN SOURCE)



- R-packages
    - **SensMixed**  
([https://r-forge.r-project.org/R/?group\\_id=1433](https://r-forge.r-project.org/R/?group_id=1433))
    - **ImerTest**  
([www.cran.r-project.org/package=ImerTest/](http://www.cran.r-project.org/package=ImerTest/))
- ( - **lme4 (Imer function)**  
([www.cran.r-project.org/package=lme4/](http://www.cran.r-project.org/package=lme4/)) )

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# Software tools by Sensometrics @DTU: (with mixed models, OPEN SOURCE)



- Stand-alone tools:
  - **PanelCheck**  
([www.panelcheck.com](http://www.panelcheck.com))



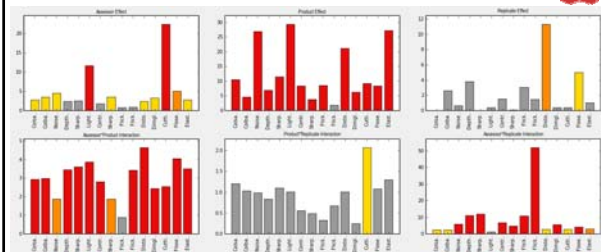
- **ConsumerCheck**  
(<http://consumercheck.co>)



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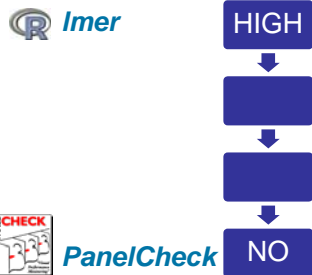
# The PanelCheck way:



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# Complexity for user



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## Complexity for user

**NEW TOOLS From DTU group:**

**HIGH** Imer

**MED** ImerTest

**LOW** SensMixed

**NO** ConsumerCheck (with NOFIMA)

PanelCheck

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## Software tools by **Sensometrics@DTU:** (BEYOND linear mixed models)

- R-packages
  - **sensR**  
([www.cran.r-project.org/package=sensR/](http://www.cran.r-project.org/package=sensR/))
  - **ordinal**  
([www.cran.r-project.org/package=ordinal/](http://www.cran.r-project.org/package=ordinal/))

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## DTU COURSE 02429

Course Base 2013/2014

Search 1 link to other versions DTU DSpace course catalogue Studyplaner Search Log in

02429 Information

Analys af korrelerede data: Mixed Lineære Modeller. / Analysis of correlated data: Mixed Linear Models

Course evaluations

02429 Analysis of correlated data: Mixed Linear Modeller E12

02429 Analysis of correlated data: Mixed Linear Modeller E11

02429 Analysis of correlated data: Mixed Linear Modeller E10

02429 Analysis of correlated data: Mixed Linear Modeller E09

02429 Analysis of correlated data: Mixed Linear Modeller E08

Graphics

02429 Analysis of Correlated Data: Mixed Linear Models v12 v11 v10 v09 v08 v07 v06

Course responsible

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## DTU COURSE 02429

### 12 modules:

- Complete online course material:  
(<http://02429.compute.dtu.dk/>)
- Online video lectures:  
(<http://02429.compute.dtu.dk/>)

– Also: Online intro stat ENGLISH podcasts!  
(<http://introstat.compute.dtu.dk/>)

**200.000 views in 2013**

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## Introduction to Mixed models: (Module 1)



- Incomplete Block Designs
- "Recovery of inter-block information"

## Example: 2 Products



10 Subjects PAIRED	1	10.4	10.1	0.3
	2	10.6	10.8	-0.2
	3	10.2	10.2	0.0
	4	10.1	9.9	0.2
	5	10.3	11	-0.7
	6	10.7	10.5	0.2
	7	10.3	10.2	0.1
	8	10.9	10.9	0.0
	9	10.1	10.4	-0.3
	10	9.8	9.9	-0.1
10 Subjects INDEP- ENDENT	11	10.8		
	12	9.8		
	13	10.5		
	14	10.3		
	15	9.7		
	16	10.3		
	17	9.6		
	18	10.0		
	19	10.2		
	20	9.9		

## Example:



	<b>Subs 1-10</b>	<b>Subs 11-20</b>
Difference	-0.05	-0.22
SE <sup>2</sup>	0.00872	0.0584
	<b>PAIRED</b>	<b>INDEP- ENDENT</b>

## Example:



The mixed model gives you the **proper weighted result:**

E.g. The **weighted difference:**

$$\hat{\beta}_2 - \hat{\beta}_1 = \frac{-0.05 \frac{1}{0.00872} - 0.22 \frac{1}{0.0584}}{\frac{1}{0.00872} + \frac{1}{0.0584}} = (0.87)(-0.05) + (0.13)(-0.22) = -0.072$$

## Example:



The mixed model gives you the **proper weighted result:**

E.g. Variance of **weighted difference:**

$$\frac{1}{\frac{1}{0.00872} + \frac{1}{0.0584}} = 0.00759$$

## Example in R:



```
# Set working Directory:
setwd("C:/perbb/Chicago2014")

# Import data:
sensintro <- read.table("introexample.csv",header=TRUE,sep="," ,dec=".")

# Make relevant variables into factors:
sensintro$assessor=factor(sensintro$assessor)

# Check your data:
head(sensintro)
summary(sensintro)
```

## Example in R:

```
# The mixed model version of it:
# We first just load the lme4 package
# If first time: first install the package
library(lme4)

# Analysing all 20 assessors:
lmer1 <- lmer(sweet~product+(1|assessor), data=sensintro)
summary(lmer1)
```

Fixed effects

Data set

Attribute

Random effects

## WHY Mixed models for Sensory and consumer??

The proper mixed model gives you the proper product information!!

In addition: **INSIGHT** into the **NOISE** structure!

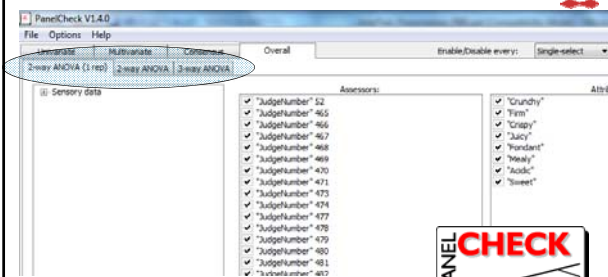
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## Available in PanelCheck



[www.panelcheck.com](http://www.panelcheck.com)  
(NOFIMA/DTU - Tormod Næs/PBB)

## Simple Mixed Models in Sensory and Consumer

- Balanced/complete simple designed sensory profile or consumer preference data:

- 2-way randomized block analysis:  $F = \frac{MS_{Prod}}{MS_{Error}}$

- 2-way randomized replicates analysis:

$$F = \frac{MS_{Prod}}{MS_{Prod*Assessor}}$$

- 3-way sessioned/batched analysis:

$$F = \frac{MS_{Prod}}{MS_{Prod*Assessor} + MS_{Prod*Session} - MS_{Error}}$$