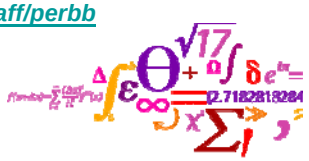
Intro to mixed models for sensory and consumer data using PanelCheck

Per Bruun Brockhoff, *Professor*

DTU Compute,

Danish Technical University

www.compute.dtu.dk/staff/perbb



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

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

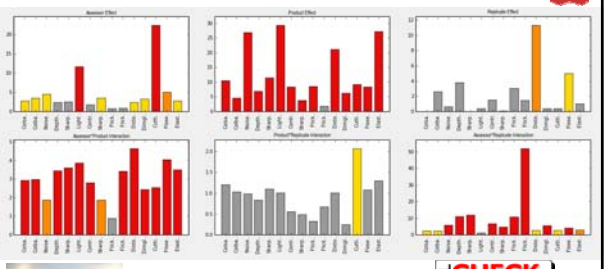
- R-packages
  - ***SensMixed*** (https://r-forge.r-project.org/R/?group_id=1433)
  - ***lmerTest*** (***www.cran.r-project.org/package=lmerTest/***)

(– ***lme4 (lmer function)*** (***www.cran.r-project.org/package=lme4/***))

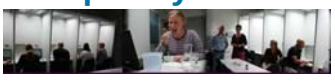
Software tools by *Sensometrics@DTU*: (with mixed models , OPEN SOURCE)

- Stand-alone tools:
  - ***PanelCheck*** (www.panelcheck.com)
  - ***ConsumerCheck*** (http://consumercheck.co)

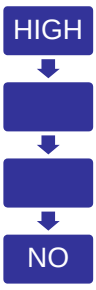
The PanelCheck way:



Complexity for user

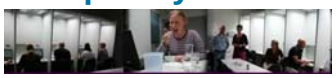


lmer



PanelCheck

Complexity for user



NEW TOOLS
From DTU group:

lmer

HIGH

MED — ImerTest

LOW — SensMixed

NO — PanelCheck

ConsumerCheck
(with NOFIMA)

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

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

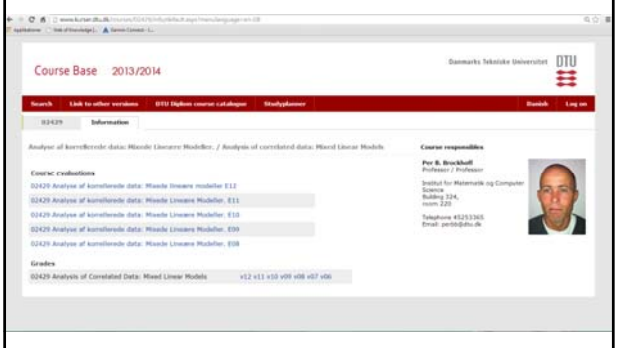
Outline, 09:00-10.30

- Mixed model software tools by DTU group
  - 4(5) R-packages
  - PanelCheck, ConsumerCheck
- Introduction to linear mixed models
- From simple to 3-way ANOVA for sensory data

Outline, 09:00-10.30

- Mixed model software tools by DTU group
  - 4(5) R-packages
  - PanelCheck, ConsumerCheck
- Introduction to linear mixed models
- From simple to 3-way ANOVA for sensory data

DTU COURSE 02429



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

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		

DIFS

Example:

	Subs 1-10	Subs 11-20
Difference	-0.05	-0.22
SE^2	0.00872	0.0584
	PAIRED	INDEP-ENDENT

Example:

The mixed model gives you the proper weighted result:

E.g. The weighted difference:

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

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:

Fixed effects

```
# 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)
```

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!

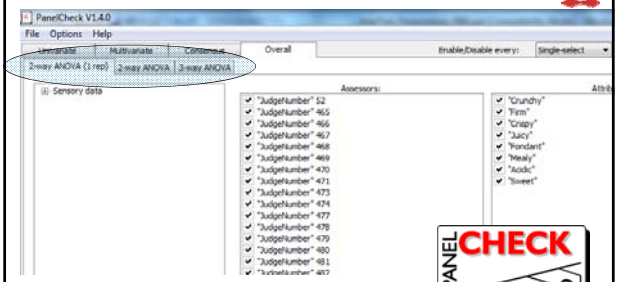
Outline, 09:00-10.30

- Mixed model software tools by DTU group
  - 4(5) R-packages
  - PanelCheck, ConsumerCheck
- Introduction to linear mixed models
- From simple to 3-way ANOVA for sensory data

Outline, 09:00-10.30

- Mixed model software tools by DTU group
  - 4(5) R-packages
  - PanelCheck, ConsumerCheck
- Introduction to linear mixed models
- From simple to 3-way ANOVA for sensory data

Available in PanelCheck



www.panelcheck.com
(NOFIMA/DTU - Tormod Næs/PBB)

PANELCHECK "Visual Performance Monitoring"

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