Are you happier if a p-value is .049 rather than .051? Did you ever have trouble finding a meaningful interpretation upon finding one or more significant test results? Did you ever worry about the interpretation of p-values when testing more than one hypothesis? Do you like large sample sizes because more tests will be significant? Did you ever quit a research project because none of the tests were significant? If you answer "yes" to one or more of these questions, and if you have one or more theories with respect to the state of affairs in you research domain, this course may be useful because it will temper your happiness, reduce your trouble, address your worries, discuss your liking, and provide an alternative for quitting, by teaching you a new way to analyze your data:

Bayesian Evaluation of Informative Hypotheses

Lecturers: Dr. Irene Klugkist and Prof. dr. Herbert Hoijtink

May 4th and 5th, 2010

In this course Bayesian evaluation of informative hypotheses will be introduced as an alternative for null-hypothesis testing. An informative hypothesis contains a researcher's expectation with respect to the state of affairs in the population of interest. If (s)he expects four means to be ordered, the hypothesis might be H1: m1>m2>m3>m4, where > denotes 'larger than'. If another scientist has other expectations, a competing hypothesis can be formulated e.g. H2: m1<m2>m3=m4. It will be shown that Bayesian model selection can be used to evaluate H1, H2 and, if desired, in addition the traditional null hypothesis (H0: m1=m2=m3=m4), without suffering from the drawbacks of hypothesis testing using p-values.

Program

May 4th

- Univariate analysis of (co)variance: the classical approach
- Limitations of null hypotheses testing
- Examples of informative hypotheses (provided by the lecturers and the students)

- Non-technical introduction of Bayesian model selection for informative hypotheses
- A psychological application
- Software demonstration (ancova software)

May 5th

- Repeated measures analysis: the classical approach
- Examples of informative hypotheses (provided by the lecturers and the students)
- Prior sensitivity in Bayesian model selection for informative hypotheses

- Power of Bayesian model selection for informative hypotheses
- Software demonstration (multivariate normal data software)
- Time for (more) questions and discussion

Target audience

The course is aimed at researchers who want to evaluate theories and move beyond exploratory data analysis. The course is aimed at researchers who are not afraid to learn a new approach for hypotheses evaluation. Explanations will be based on illustrations using concrete data and corresponding hypotheses, formulas will not play a role in this course.

Preparation
Students should prepare this course by reading the first two chapters from the book 'Bayesian evaluation of informative hypotheses' (Springer, 2008). The chapters are attached as pdf-file. Note that the content is not technical. It introduces the concept "informative hypothesis" and provides three illustrations from psychological research that are difficult to evaluate using a classical (null hypothesis testing) approach.

In addition to reading these two chapters we ask the students to think about their own research (past, present or future) and try to formulate one or more informative hypotheses for this research. These examples preferably fit in the framework of analysis of (co)variance with between and/or within factors (including longitudinal research, i.e., repeated measurements).

Book:
Hoijtink, H., Klugkist, I. and Boelen, P.A., Eds. (2008). *Bayesian evaluation of informative hypotheses.* New York: Springer.

See also: www.fss.uu.nl/ms/informativehypotheses (e.g. software and manuals)

Papers presenting applications of evaluating informative hypotheses

Kammers, M.P.M., Mulder, J., De Vignemont, F., Dijkerman, C. (in press). The weight of representing the body: addressing the potentially indefinite number of body representations in healthy individuals, *Experimental Brain Research*.

Van Well, S., Kolk, A.M. and Klugkist, I.G. (2008*)*. Effects of Sex, Gender Role Identification, and Gender relevance of Two Types of Stressors on Cardiovascular and Subjective Responses: Sex and Gender Match/Mismatch Effects. *Behavior Modification,* 32, 427-449*.*

Laudy, O., Zoccolillo, M., Baillargeon, R., Boom, J., Tremblay, R. and Hoijtink, H. (2005). Applications of confirmatory latent class analysis in developmental psychology. *European Journal of Developmental Psychology,* 2*,* 1-15*.*

Papers presenting statistical theory with respect to informative hypotheses

Mulder, J., Klugkist, I., Van de Schoot, R., Meeus, W., Selfhout, M., Hoijtink, H. (in press). Informative Hypotheses for Repeated Measurements: A Bayesian Approach. *Journal of Mathematical Psychology.*

Mulder, J., Hoijtink, H., Klugkist, I. (in press). Equality and Inequality Constrained Multivariate Linear Models: Objective Model Selection Using Constrained Posterior Priors. *Journal of Statistical Planning and Inference.*

Van de Schoot, R., Dekovic, M., and Hoijtink, H. (in press). Testing inequality constrained hypotheses in SEM models. *Structural Equation Modelling.*

Klugkist, I. and Hoijtink, H. (2007). The Bayes Factor for Inequality and About Equality Constrained Models. *Computational Statistics and Data Analysis,* 51, 6367-6379.

Hoijtink, H. and Klugkist, I. (2007). Comparison of Hypothesis Testing and Bayesian Model Selection. *Quality and Quantity, 41,* 73-91.

Laudy, O., and Hoijtink, H. (2007). Bayesian methods for the analysis of inequality constrained contingency tables. *Statistical Methods in Medical Research, 16*, 123-138.

Kato, B.S. and Hoijtink, H. (2006). A Bayesian approach to inequality constrained linear mixed models: estimation and model selection. *Statistical Modelling*, 6, 231-249.

Klugkist, I., Laudy, O. and Hoijtink, H. (2005). Inequality Constrained Analysis Of Variance: A Bayesian Approach. *Psychological Methods,* 10 (4), 477-493.

Laudy, O., Boom, J., Hoijtink, H. (2004). Bayesian computational methods for inequality constrained latent class analysis. In: A. van der Ark, M. Croon, K. Sijtsma. *New developments in categorical data analysis for the social and behavioral sciences*. Mahwah, N.J.: Erlbaum.

Hoijtink, H. (2001). Confirmatory latent class analysis: model selection using Bayes factors and (pseudo) likelihood ratio statistics. *Multivariate Behavioral Research,* 36, 563-588.