

# CURSUSSEN STATISTIEK

PERMANENTE VORMING IN DE WETENSCHAPPEN

# COURSES IN STATISTICS

CONTINUING EDUCATION IN SCIENCE





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CONTINUING EDUCATION IN SCIENCE





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## Center for Statistics Centrum voor Statistiek



Krijgslaan 281 – S9, 9000 Ghent  
[www.cvstat.UGent.be](http://www.cvstat.UGent.be)

## Institute for Continuing Education in Science



Several courses in this series are part of the Doctoral Schools programs. Visit your DS website for more information.

## Instituut voor Permanente Vorming in de Wetenschappen



Meerdere cursussen uit deze reeks zijn opgenomen in de UGent Doctoral Schools programma's. Ga naar de DS website voor meer informatie.

Krijgslaan 281 – S9, 9000 Ghent

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**F** 09 264 85 90

[ipvw.ices@UGent.be](mailto:ipvw.ices@UGent.be)

[www.ipvw-ices.UGent.be](http://www.ipvw-ices.UGent.be)

- 1 Fac. of Psychology and Educational Sciences (PP) – H. Dunantlaan 1
- 2 Fac. of Psychology and Educational Sciences (PP) – H. Dunantlaan 2
- 3 Fac. of Sciences (WE) – Campus Sterre, Krijgslaan 281, building S9
- 4 Adviescentrum voor Studenten
- 5 Station Gent-Sint-Pieters





**T**he power of data and the information therein is entering the heart of almost any section of society. We are discovering that processes can be better understood and controlled, predictions made, causal effects estimated and decisions optimized. Reliable results follow when studies have been appropriately designed, data carefully gathered and analyzed. Scientists and professionals alike add tremendously to their market value when data analytic skills are merged with their subject matter expertise.

To prepare for 'big data' in tomorrow's world and to face the facts with statistical skills, the Ghent Center for Statistics joins the Institute for Continuing Education of the Faculty of Sciences (ICES) to organize their yearly series of targeted training modules. We aim to provide insight in the basics of statistical research while developing the technical skills to come to results with statistical software.

Blended learning with hands-on sessions on PC's or laptops allows participants to gain firsthand experience in applying the knowledge. Our courses target professionals and the academically trained, who wish to refresh their knowledge or discover new areas of research. The program's modular architecture facilitates flexible entry and adaptive training trajectories.

The Flemish Community recognizes the value of lifelong learning for the region's industry and economic development. Employers are granted financial support through the government's introduction of the KMO-portfolio. More about this

stimulation initiative can be found on the website: [www.kmo-portefeuille.be](http://www.kmo-portefeuille.be) (in Dutch).

Doctoral Schools aim to support young researchers in acquiring the necessary skills. Several modules can therefore under certain conditions, be incorporated in the program of the Doctoral Schools.

For the 2015-2016 academic year, the program offers a classic series of basic modules which gradually build up statistical knowledge and techniques, preceded by two courses introducing the statistical software SPSS and R, a commercial and a freeware package, respectively. This is traditionally followed by more specialized courses: 'Causal

Mediation Analysis' starts in November 2015, 'Experimental Design' starts in March 2016, 'Multilevel Analysis for Grouped and Longitudinal Data' and 'Applied Longitudinal Analysis' kick off in April 2016. Except for Module 2, all modules are taught in English.

Classes take place in a pleasant

atmosphere with ample opportunity to interact with lecturers. Information about additional short courses is posted on our website [www.ipw-ices.UGent.be](http://www.ipw-ices.UGent.be) or you can subscribe to our mailing list. Complementary statistical training and consulting services at Ghent University are found through its Center for Statistics, [www.cvstat.ugent.be](http://www.cvstat.ugent.be). Wishing you an enjoyable and rewarding learning experience, we look forward to meeting you,

## **'MERGE DATA ANALYTIC SKILLS WITH YOUR SUBJECT MATTER EXPERTISE'**

**Professor Els Goetghebeur**  
Director ICES

# ADDITIONAL TRAINING AND CONSULTING SERVICES AT GHEENT UNIVERSITY

## Training

### FLAMES



Flames, Flanders training network in Methodology and Statistics ([www.flames-statistics.eu](http://www.flames-statistics.eu)) is an interuniversity initiative providing further training to young researchers in Ghent and beyond.

Contact: [flames@UGent.be](mailto:flames@UGent.be)

### One year Master in Statistical Data Analysis

The UGent advanced Master's program in Statistical Data Analysis leads to a dedicated degree following more intensive training in the methods of practical statistics offered to scientists in diverse areas.

## Consulting

### FIRE

The FIRE (Fostering Innovative Research based on Evidence) statistical consulting service offers statistical and methodological support for UGent doctoral students and post-docs conducting scientific research. Personalized advice and technical help is provided during all phases of the research including study design (most important!), data collection, statistical analysis, and interpretation and reporting of results.

Book your FIRE consult by filling out the application form at [www.cvstat.ugent.be/FIRE](http://www.cvstat.ugent.be/FIRE) or, contact us at [fire@ugent.be](mailto:fire@ugent.be) for more information.

## Stat-Gent CRESCENDO

Stat-Gent CRESCENDO unites statistical expert knowledge across the Ghent University Center for Statistics aiming to support applied research. It provides consulting services in collaboration with the private sector, the public sector, and other research groups.

We offer an operational framework for statistics and data analysis contract work. The flexible format includes data analysis projects, customized training and software solutions. Data analysis projects add maximum value when the statistical method is integrated in the complete trajectory from objective setting to report writing. We therefore strive for stable

and sustained relationships with our partners in mutually rewarding research collaborations.

High-quality work is delivered by well-trained and dedicated statistical consultants, under guidance and supervision of UGent statistics professors. Stat-Gent has expertise in a broad range of applications, such as (but not limited to):

- design and analysis of clinical trials
- health economics, epidemiology, electronic health records, quality of care, drug compliance, and evidence-based medicine
- business analytics
- biotech and agriculture
- statistical genetics/genomics: biomarkers,



micro-arrays, qPCR, next-generation sequencing

We use a wide variety of statistical methods going from basic regression, analysis of variance, mixed models and multivariate techniques, to more specific methods in causal analysis, data mining, functional data analysis, experimental design, longitudinal analysis, missing data, multiple testing, robust and non-parametric statistics and survival analysis.

Do not hesitate to contact us with questions or for more information at [statgent@ugent.be](mailto:statgent@ugent.be).



# INTRODUCTION TO R

## Target audience

- This course targets professionals and investigators from diverse areas with little to no R-programming experience who wish to start using R for their data manipulation, data exploration or statistical analysis.

## Teacher

- Joris Meys is a statistical consultant in the Biostatistics Department at Ghent University. He is co-author (with Andrie de Vries) of 'R for Dummies' (Wiley, 2012).
- He is an accomplished R programmer, and produces R packages both for specific research projects and, via R-Forge, for more general application. His statistical expertise is in the areas of ecotoxicology, analysis of environmental data, clinical research and meta analysis.

## Course prerequisites

- The course is open to all interested persons.
- Knowledge of basic statistical concepts and experience with other programming languages are considered advantageous, but not required for learning the R language.

R is an environment for statistical computing and graphics, which is becoming increasingly popular as a tool to get insight in often complex data. While in some ways similar to other programming languages (such as C, Java and Perl), R is particularly suited for data analysis because ready-made functions are available for a wide variety of statistical (classical statistical tests, linear and nonlinear modeling, timeseries analysis, classification, clustering, ...) and graphical techniques. The base R program can be extended with user-submitted packages, which means new techniques are often implemented in R prior to being available in other software. This is one of the reasons why R is becoming the de facto standard in certain fields such as bioinformatics (Bioconductor) and financial services.

This course introduces the use of the R environment for the implementation of data management, data exploration, basic statistical analysis and automation of procedures. The course starts with a description of the R GUI, the use of the command line and an overview of basic data structures. The application of standard procedures to import data or to export results to external files will be illustrated. Creation of new variables, subsetting, merging and stacking of data sets will be covered in the data management section. Exploration of the data by histograms, box plots, scatter plots, summary numbers, correlation coefficients and cross-tabulations will be performed.

Simple statistical procedures that will be covered are:

- comparison of observed group means (t-test, ANOVA and their nonparametric versions) and proportions
  - test for independence in 2-way cross tables and linear regression (focusing on the implementation in R of the statistical methods that form the subject of other modules of the statistics course)
- Finally, installing new packages and automation of analysis procedures will also be discussed.

Practical sessions and specific exercises will be provided to allow participants to practice their R skills in interaction with the teacher.

## Exam

- There is no exam connected to this module. Participants receive a certificate of attendance at the end of the course.
- To qualify for reimbursement from the UGent Doctoral Schools one must attend all classes. Visit the ICES website and your DS website for more information.

## Course material

- Copies of slides.
- Recommended handbook (optional): "R for Dummies", J. Meys & A. de Vries, 2<sup>nd</sup> ed. (2015), Wiley, ISBN 978-1119055808.

## Fees

- The registration fee amounts to 325 EUR. Reduced prices apply to students and participants of nonprofit and public services. These prices are available at the ICES website.
- The book is optional and can be bought at the additional cost of 30 EUR. Please indicate this clearly on the registration form.

## Dates and venue

October 5, 8, 19 and 22, 2015 from 5.30 pm to 9 pm.  
Faculty of Psychology and Educational Sciences,  
H.Dunantlaan 1 + 2  
Ghent.



## INLEIDING TOT SPSS

### Doelpubliek

- Deze practica zijn gericht op alle personen die gegevens verzamelen en/of opslaan, met de bedoeling deze statistisch te analyseren en interpreteren.

### Lesgever

- Kris Erauw (UGent) is beleidsmedewerker onderwijsinnovatie bij de dienst onderwijsondersteuning van de Faculteit Psychologie en Pedagogische Wetenschappen aan de Universiteit Gent. Hij stond jarenlang mee in voor de begeleiding van studenten bij de vakken statistiek en methodologie en bij het schrijven van hun masterproef. Vandaag is hij onder andere actief in het ontwikkelen van online oplossingen voor dataverzameling en dataverwerking.

### Toelatingsvoorwaarden

- Geen.

We leven in een kennismaatschappij. Heel veel mensen verzamelen gegevens of willen bepaalde ideeën met onderzoeksbevindingen ondersteunen. Denk aan de jongeren die hun jeugdwerkbeleidsplan moeten ondersteunen met onderzoeksbevindingen; of aan de voorzitter van een oudercomité die standpunten op een wetenschappelijk verantwoorde manier bij de ouders wil toetsen. Het inzamelen en opslaan van al die gegevens is vaak niet zo evident als het lijkt. Zeker niet als het de bedoeling is de gegevens later op een professionele manier te verwerken.

**D**eze lessenreeks is er op gericht data in een bruikbare vorm te verzamelen, de ingezamelde data in SPSS op te slaan en met SPSS de eerste beschrijvende statistieken te produceren. Het is geen introductie statistiek maar in de eerste plaats een cursus die je vertrouwd wil maken met SPSS. De verschillende lessen in de reeks zijn ervaringsgericht opgevat. De deelnemers worden met een aantal problemen geconfronteerd waarna mogelijke oplossingen besproken en gemonstreerd worden.

**Les 1** *Data en dataverzameling:* data in SPSS invoeren en definiëren.

**Les 2** *Elementaire bewerkingen en beschrijvende statistiek:* samenvattende statistieken en voorstellingen genereren, variabelen herschrijven en combineren, databestanden bewerken en combineren.

**Les 3** *Toetsen:* van beschrijvende statistiek naar besluitvormende statistiek. Wat vind je waar in SPSS.

**Les 4** *Haal meer uit je databestand:* grafische voorstelling van gemiddelden, t-toetsen en variantie-analyse.

### Examen

- Er is geen examen verbonden aan deze module. Deelnemers ontvangen een aanwezigheidscertificaat aan het einde van de cursus.
- Om in aanmerking te komen voor een terugbetaling door de UGent Doctoral Schools moeten men aan alle lessen deelnemen. Ga naar de IPVW-website of je DS-website voor meer informatie.

### Lesmateriaal

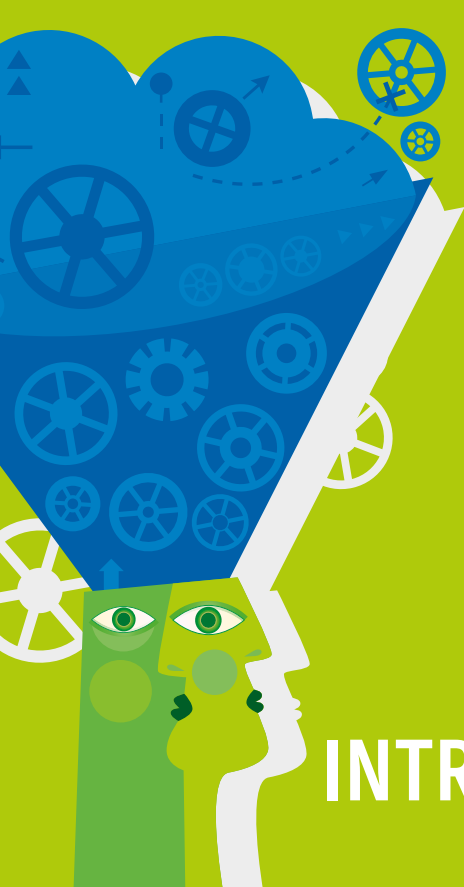
- Oefeningenbundel.

### Prijs

- De deelnameprijs bedraagt 325 EUR. Gereduceerde prijzen gelden voor studenten en personeel in de non-profit- en overheidssector. Deze vindt u op de IPVW-website.

### Data en locatie

- 12, 13, 15 en 16 oktober 2015, telkens van 17u tot 20u.
- Faculteit Psychologische en Pedagogische Wetenschappen, Henri Dunantlaan 1 + 2, Gent.



# INTRODUCTORY STATISTICS

## BASICS OF STATISTICAL INFERENCE

### Target audience

- This course will benefit professionals and investigators from diverse areas, including research scientists and clinical research associates, investing in data handling and wishing to acquire insight into basic statistical methods or to refresh their knowledge and practice of statistics.

### Teacher

- Dr. Els Adriaens (Adriaens Consulting bvba) studied biology, obtained a PhD in pharmaceutical sciences and a Master in Statistical Data Analysis at Ghent University.
- She is consultant in statistical data analysis specialized in the field of the development and validation of alternatives to laboratory animals.

### Course prerequisites

- The course is open to all interested persons. It is necessary to have an understanding of basic algebra (basic rules of calculation, solving simple equations, ...), and have a working knowledge of exponents and square roots.

### Exam

- Participants can, if they wish, take part in an exam. Upon succeeding in this test a certificate from Ghent University will be issued to participants with a university degree at the bachelor level or an equivalent degree.
- To qualify for reimbursement from the UGent Doctoral Schools one must attend all classes and pass the exam. Visit the ICES website and your DS website for further information.



This course aims to provide insight into basic statistical concepts with emphasis on practical applications. Mathematical formulae are kept to a minimum. The theory and the methods of analysis will be extensively illustrated with examples relating to a wide variety of different fields.

**W**e start with concise graphical and numerical **descriptions of data** obtained from observational or experimental studies. The most common and frequently used **probability distributions** of discrete and continuous variables will be presented. Statistical inference draws **conclusions** about a popu-

lation based on sampled data. Chance variations are taken into account such that a level of **confidence** is attached to these conclusions.

We present the reasoning behind **significance tests** for the comparison of observed data with a hypothesis. We apply this procedure to data obtained either from one or from two populations.

The **correct use of the t-test** will be discussed. **Nonparametric methods** are considered as a possible alternative in case the requirements of the t-test are not met.

We cover the basic concepts of **hypothesis testing for**

**categorical data**, including the chi-square test.

Quite often the relationship between two variables, where the outcome of one variable is seen as depending on the value of the other, is the focus of scientific interest. We will give an **introduction to linear regression** analysis, where a regression line based on observations obtained in a sample describes the expected outcome.

Hands-on **exercises** are worked out behind the PC using the **SPSS software**. If preferred, participants can use SAS or R.

## Course material

- Copies of slides.
- Recommended handbooks (optional):
- Medical field: Book 1: "Fundamentals of Biostatistics", B. Rosner, 8<sup>th</sup> ed. (2015), Cengage, ISBN 978-0538733496. The examples used in this book are restricted to the field of bioscience. The book is therefore recommended if you have a background in a related research area, such as (veterinary) medicine, biotechnology, biology, pharmacy, a.s.o.
- All fields: Book 2: "Introduction to the Practice of Statistics", D.S. Moore, G.P. McCabe and B. Craig, 8<sup>th</sup> revised ed. (2014), W.H. Freeman, ISBN 978-1464158933. This book uses examples from a wide range of research areas and is therefore recommended if you have no background in the research areas mentioned for book 1.

## Fees

- The registration fee amounts to 800 EUR. Reduced prices apply to students and participants of nonprofit and public services. These prices are available at the ICES website.
- Both books are optional and can be bought at the additional cost of 120 EUR for book 1 and 85 EUR for book 2. Please indicate this clearly on the registration form.
- The examination fee is 30 EUR.

## Dates and venue

- November 10, 17 and 24, December 1, 8, 15 and 22, 2015 from 5.30 pm till 9.30 pm. Each lecture is followed by a hands-on practical session in SPSS.
- Faculty of Science, Building S9, Campus Sterre, Krijgslaan 281, Ghent.



# CAUSAL MEDIATION ANALYSIS

## Target audience

This course will benefit medical investigators, sociologists, psychologists, research scientists, clinical research associates, ... who need to use statistical methods for mediation analysis or wish to develop a better understanding of techniques for confounder control.

## Teachers

Prof. dr. Tom Loeys is Professor at Ghent University, Department of Data Analysis, Faculty of Psychology and Educational Sciences. His methodological interests include causal mediation analysis and dyadic data analysis. He also worked in the pharmaceutical industry, where he was involved in the design and analysis of clinical trials.

Prof. dr. Beatrijs Moerkerke is Professor at Ghent University, Department of Data Analysis, Faculty of Psychology and

Educational Sciences. She teaches courses in statistics and methodology to students in psychology and educational sciences. Her current research interests include causal mediation analysis and the analysis of brain imaging data.

Prof. dr. Stijn Vansteelandt is Professor at Ghent University, Department of Applied Mathematics and Computer Sciences, Faculty of Science. He teaches courses in statistics to students in the Faculty of Science, the Faculty of Pharmaceutical Science and the Masters

program in Statistical Data Analysis. He did post-doctoral research at the Harvard School of Public Health and Ghent University. His current research focuses mainly on mediation analysis and estimation of the causal effect of time-varying exposures in longitudinal studies.

## Course prerequisites

Participants are expected to be familiar with the basic principles of statistical inference, linear and logistic regression analysis. Some familiarity with R is an asset.

This course aims to provide tools for estimating direct and indirect effects of exposure on outcome. It will introduce standard structural equation models as well as more flexible causal inference methods.

In observational epidemiology, psychology and sociology, there is substantive interest in separating direct exposure effects from indirect effects that are mediated through given intermediate variables. The use of mediation analysis has thus become quite common, especially in the social and psychological sciences, where a method based on regression analysis advocated by Baron and Kenny is now utilized routinely. More recently, an approach to mediation arising from

the causal inference literature and based on the notion of counterfactuals has been proposed. This has led to an improved understanding of the conditions under which the standard regression approach to mediation analysis is valid and to novel techniques that enable effect decomposition of a total effect into a direct and indirect effect in much more general settings than those commonly considered. The newer techniques can handle nonlinear models, interactions, ... and more appropriate adjustment for confounding.

In this course, we will first give an introduction to traditional mediation analysis under

linear structural equation models with a single or multiple mediators, and we will discuss extensions to multilevel designs. We will next introduce modern mediation analysis approaches based on so-called natural direct and indirect effects. Flexible state-of-the-art estimation techniques based on the mediation formula will be introduced, along with imputation strategies for a general class of natural effect models for mediation analysis. Emphasis will be on concrete methods in an up-to-date survey of current status in the area. Computer demonstrations in the freeware statistical software package R will be included, without assuming prior familiarity with the software.

## Exam

- Participants can, if they wish, take part in an exam. Upon succeeding in this test a certificate from Ghent University will be issued to participants with a university degree at the bachelor level or an equivalent degree.
- To qualify for reimbursement from the UGent Doctoral Schools one must attend all classes and pass the exam. Visit the ICES website and your DS website for further information.

## Course material

- A full set of slides will be provided. The course will be based on current, accessible papers, and a full reading list will be available ahead of the course.
- Recommended book (optional): VanderWeele, T.J. (2015). *Explanation in Causal Inference: Methods for Mediation and Interaction*, OUP, ISBN 978-0199325870.

## Fees

- The registration fee amounts to 800 EUR. Reduced prices apply to students and participants of nonprofit and public services. These prices are available at the ICES website.
- The book is optional and can be bought at the additional cost of 70 EUR. Please indicate this clearly on the registration form.
- The examination fee is 30 EUR.

## Dates and venue

- November 16, 19, 23, 26 and 30, December 3, 2015 from 5.30 pm till 9 pm.
- Faculty of Science, Building S9, Campus Sterre, Krijgslaan 281, Ghent.



# ANALYSIS OF VARIANCE

## Target audience

- This course targets professionals and investigators from diverse areas, who need to use statistical methods in the collection and handling of data in their research, in particular for assessing the effect of e.g. different treatments.

## Teacher

- Dr. Els Adriaens (Adriaens Consulting bvba) studied biology, obtained a PhD in pharmaceutical sciences and a Master in Statistical Data Analysis at Ghent University.
- She is consultant in statistical data analysis specialized in the field of the development and validation of alternatives to laboratory animals.

## Course prerequisites

- Participants are expected to have an active knowledge of the basic principles underlying statistical strategies, at a level equivalent to the "Introductory Statistics" course of this program.
- In the first session on January 12, 2016, these principles will be briefly reviewed. This review session is open to interested participants of subsequent modules. Participants who have recently followed the introductory course are exempt from that first session.

Analysis of variance (ANOVA) is a statistical tool used in the comparison of means of a random variable over populations that differ in one or more characteristics (factors), e.g. treatment, age, sex, subject, etc.

**F**irst, we cover **one-way ANOVA**, where only a single factor is of concern. Depending on the type of the factor, the conclusions pertain to just those factor levels included in the study (**fixed factor model**), or to a population of factor levels of which we observed a sample

(**random effects model**).

In two-way and **multi-way ANOVA** where populations differ in more than one characteristic, the effects of factors are studied simultaneously. This yields information about the main effects of each of the factors as well as about any special joint effects (**factorial design**). We also consider **nested designs**, where each level of a second (mostly random) factor occurs in conjunction with only one level of the first factor. One special challenge in multi-way ANOVA lies in verifying the assumptions

that must be satisfied.

In this course we will focus on correct execution of data analysis and understanding its results. We pay attention to expressing these conclusions in a correct and understandable way. The different methods will be extensively illustrated with **examples from scientific studies in a variety of fields**.

Hands-on **exercises** are worked out behind the PC using the **SPSS software**. If preferred, participants can use SAS or R.

## Exam

- Participants can, if they wish, take part in an exam. Upon succeeding in this test a certificate from Ghent University will be issued to participants with a university degree at the bachelor level or an equivalent degree.
- To qualify for reimbursement from the UGent Doctoral Schools one must attend all classes and pass the exam. Visit the ICES website and your DS website for further information.

## Course material

- Handouts of slides.
- Recommended handbook (optional): "Applied Linear Statistical Models", M.H. Kutner, C.J. Nachtsheim, J. Neter and W. Li, 5<sup>th</sup> ed. (2004), McGraw-Hill, ISBN 978-0071122214.
- Please note that this is the same book as recommended for Module 6 "Applied Linear Regression".

## Fees

- The registration fee amounts to 800 EUR. Reduced prices apply to students and participants of nonprofit and public services. These prices are available at the ICES website.
- The book is optional and can be bought at the additional cost of 70 EUR. Please indicate this clearly on the registration form.
- The examination fee is 30 EUR.

## Dates and venue

- January 12, 19 and 26, February 2, 9, 16 and 23, 2016, from 5.30 pm to 9.30 pm. Each lecture, except on January 12, is followed by a hands-on practical session in SPSS.
- Faculty of Science, Building S9, Campus Sterre, Krijgslaan 281, Ghent.



# APPLIED LINEAR REGRESSION

## Target audience

- This course targets professionals and investigators from all areas who are involved in prediction problems or need to model the relationship between a dependent variable and one or more explanatory variables.

## Teacher

- Lizzy De Lobel (Stat-Gent Crescendo, Consulting, UGent) studied Mathematics, Statistical Data Analysis and Statistical Genomics at Ghent University, where she also worked as a teaching assistant.
- She currently works as consultant for the Stat-Gent consortium. Her experience in teaching and consulting on model building will contribute greatly to this course.

## Course prerequisites

- Participants are expected to have an active knowledge of the basic principles underlying statistical strategies, at a level equivalent to the "Introductory Statistics" course of this program.
- In the first session of Module 5 'Analysis of Variance', on January 12, 2016, these principles will be briefly reviewed. This session is free and open to interested participants of this year's program.

Linear regression addresses how a continuous dependent variable is affected by one or more predictors. The fact that many practical problems deal with continuous outcomes (e.g. income, blood pressure, temperature, affect) makes linear regression a popular tool, and most of us will be familiar with the concept of drawing a line through a cloud of data points.

**T**he first two sessions of this module introduce the conceptual framework of this method using the simple case of a **single predictor**. Formulas and technicalities are kept to a minimum and the main focus is on **interpretation** of results and **assessing model validity**. This includes

confidence statements on the predictor effect (hypothesis tests and confidence intervals), using the regression model to **predict** future **results**, and verification of model assumptions.

In session 3 and 4 we allow for more than one predictor leading to the multiple linear regression model. We focus on either explanation or prediction. How to come to a **parsimonious model starting from a large number of predictors** will be discussed in detail. In these complex linear models special attention will be given to interpreting individual predictor effects, as they critically depend on other terms in the model and underlying relations

between predictors (confounding and interaction).

In the last session a more elaborate data analysis is discussed. We touch on problems where linear regression is not appropriate and replaced by related approaches such as generalized linear models and mixed models.

Different features will be illustrated with case examples from the instructors practical experience, and participants are encouraged to **bring examples** from their own work. Hands-on **exercises** are worked out behind the PC using the **SPSS software**. If preferred, participants can use SAS or R.

### Exam

- Participants can, if they wish, take part in an exam. Upon succeeding in this test a certificate from Ghent University will be issued to participants with a university degree at the bachelor level or an equivalent degree.
- To qualify for reimbursement from the UGent Doctoral Schools one must attend all classes and pass the exam. Visit the ICES website and your DS website for further information.

### Course material

- Copies of lecture notes.
- Recommended handbook (optional): "Applied Linear Statistical Models", M.H. Kutner, C.J. Nachtsheim, J. Neter and W. Li, 5<sup>th</sup> ed. (2004), McGraw-Hill, ISBN 978-0071122214. Please note that this is the same book as recommended for Module 5 "Analysis of Variance".

### Fees

- The registration fee amounts to 800 EUR. Reduced prices apply to students and participants of nonprofit and public services. These prices are available at the ICES website.
- The book is optional and can be bought at the additional cost of 70 EUR. Please indicate this clearly on the registration form.
- The examination fee is 30 EUR.

### Dates and venue

- March 1, 8, 15, 22 and 29, 2016 from 5.30 pm to 9.30 pm. Each lecture is followed by a hands-on practical session in SPSS.
- Faculty of Science, Building S9, Campus Sterre, Krijgslaan 281, Ghent.



# EXPERIMENTAL DESIGN

## Target audience

- This course targets professionals and investigators from all areas who are involved in designing experiments or are interested in a better understanding of how the design of an experiment is related to the data analysis.

## Teacher

- Dr. Jan De Neve obtained his PhD in Statistical Data Analysis at Ghent University and is currently doctor-assistant at the Department of Mathematical Modeling, Statistics and Bio-informatics at the Faculty of Bioscience Engineering (Ghent University). He teaches the courses 'Experimental Design' and 'Statistical Topics in Food Technology'. In the past he was involved in several teaching duties for both applied and methodological courses.

## Course prerequisites

- Participants are expected to have an active knowledge of:
  - R
  - linear regression and ANOVA
  - basic matrix algebra



Study design is arguably the most important aspect of any empirical research project. Its impact on the statistical analysis to follow and on the conclusions that can be drawn should not be underestimated.

Timely input of statistical know how and experience can do wonders at this stage. We illustrate this fact through several examples in this course and give participants the basic tools to set-up cost-efficient study designs.

The course content is closely related to the theory and practice of **linear statistical models** (e.g. regression analysis and analysis of variance). Although the design phase of a study appears prior to the experimentation and statistical analysis phases, a **design** is

constructed in function of the data analysis that will follow. A good knowledge of the theory of linear statistical models is therefore important. The key role of experimental design in scientific and operational research is evident. A good design allows for correct interpretation and **relevant results** of the statistical analysis following the experiment. Moreover, **efficiency** in terms of **cost versus precision** may be considerably increased by choosing an appropriate design. The aim of this course is not only to teach how to design studies, but also more generally to

broaden the understanding of the relation between experimentation and **inference**. Some topics that will be addressed:

- general concepts: randomization, blocking and stratification, bias, **confounding**
  - **sample size calculation**: exact and approximation methods using simulation
  - **optimal designs**: methods based on the Fisher information matrix (e.g. A, D and E optimality), orthogonality of a design, designs for parameter estimation versus prediction
- Hands-on **exercises** are worked out behind the PC using the **R software**.

## Exam

- Participants can, if they wish, take part in an exam. Upon succeeding in this test a certificate from Ghent University will be issued to participants with a university degree at the bachelor level or an equivalent degree.
- To qualify for reimbursement from the UGent Doctoral Schools one must attend all classes and pass the exam. Visit the ICES website and your DS website for further information.

## Course material

- Syllabus.
- Recommended handbooks (optional):
  - Book 1: "Optimal design of experiments: a case study approach", P. Goos and J. Bradley, (2011), John Wiley & Sons, ISBN 978-0470744611.
  - Book 2: "Design and analysis of experiments", D.C. Montgomery, (2008), John Wiley & Sons, ISBN 978-8126540501.

## Fees

- The registration fee amounts to 500 EUR. Reduced prices apply to students and participants of nonprofit and public services. These prices are available at the ICES website.
- The books are optional and can be bought at the additional cost of 80 EUR each. Please indicate this clearly on the registration form.
- The examination fee is 30 EUR.

## Dates and venue

- March 29 and 31, 2016, from 9 am till 4 pm.
- Faculty of Science, Building S9, Campus Sterre, Krijgslaan 281, Ghent.



# MULTILEVEL ANALYSIS

## FOR GROUPED AND LONGITUDINAL DATA

### Target audience

- This course targets professionals and investigators from diverse areas ranging from researchers in the behavioral and social sciences to whoever deals with data with a hierarchical or multilevel structure.

### Teacher

- Prof. dr. Leoniek Wijngaards-de Meij is Professor in Applied Statistics at the Department of Methodology and Statistics of the Faculty of Social Sciences at Utrecht University, the Netherlands. She received a Master in Clinical Psychology and a PhD in Dyadic processes of parents grieving their child in Clinical Psychology at Utrecht University.
- She has worked as statistical consultant on multilevel analysis for numerous social science

research projects.

- She has been teaching courses on Multilevel Analysis at both the Graduate and Undergraduate level. These courses include Multilevel for Research Masters, ML Minor courses and a Multilevel Summer School at Utrecht University, and PhD courses for several institutes including the KLI (Research Institute for Social Psychology), the EPP (Research Institute for PsychoPathology) and the Erasmus University.

### Course description

The course assumes reasonable familiarity with analysis of variance and multiple regression analysis, but prior knowledge of multilevel modeling is not assumed.

Social research often concerns relationships between individuals and the social contexts to which they belong. Individuals and their social contexts can be conceptualized as a **hierarchical structure**, with individuals **nested within groups**. Classical examples are educational research, with pupils nested within schools, and cross-national research, with individuals nested within their national units. They involve two level data: group level and individual level variables. We need multilevel modeling to study the relationships between variables observed at different levels in the hierarchical structure. This can also cover longitudinal research, by viewing measurement occasions as nested within respondents, and extends to situations where data have a more complex multilevel structure, such as cross-classified data or multiple-membership models.

**T**his short course is intended as a basic and **nontechnical introduction** to multilevel analysis. It starts with a description of

some examples, and shows why **multilevel models** are necessary if the data have a hierarchical structure. It then covers the basic theory of two- and three-level

models. Next it explains how multilevel models can be applied to analyze **longitudinal data**, and why and when this may be an attractive analysis approach, as compared to more classical analysis methods such as multivariate analysis of variance (Manova). The course includes **three computer labs**, where multi-group and longitudinal data are analyzed. The computer labs in the course use the **multilevel program HLM and the SPSS Mixed procedure**, which is available in SPSS starting with version 11.5.

## Exam

- Participants can, if they wish, take part in an exam. Upon succeeding in this test a certificate from Ghent University will be issued to participants with a university degree at the bachelor level or an equivalent degree.
- To qualify for reimbursement from the UGent Doctoral Schools one must attend all classes and pass the exam. Visit the ICES website and your DS website for further information.

## Course material

- Copies of course notes.
- The course is based on: "Multilevel Analysis. Techniques and Applications", J.J. Hox (2010), 2<sup>nd</sup> ed., New York: Routledge, ISBN 978-1848728462.

## Fees

- The registration fee amounts to 900 EUR. Reduced prices apply to students and participants of nonprofit and public services. These prices are available at the ICES website.
- The book is optional and can be bought at the additional cost of 50 EUR. Please indicate this clearly on the registration form.
- The examination fee is 30 EUR.

## Dates and venue

- April 6, 7 and 8, 2016, from 9 am till 4 pm.
- Faculty of Psychology and Educational Sciences, Dunantlaan 1, Ghent.



# APPLIED LONGITUDINAL ANALYSIS

## Target audience

- This course will benefit medical investigators, research scientists, psychologists, ... who need to use statistical methods for analyzing data that are collected over time.

## Teacher

- Prof. dr. Tom Loeys is Professor at Ghent University, Department of Data Analysis, Faculty of Psychology and Educational Sciences. His methodological interests include causal mediation analysis and dyadic data analysis. He also worked in the pharmaceutical industry, where he was involved in the design and analysis of clinical trials.
- Prof. dr. Stijn Vansteelandt is Professor at Ghent University, Department of Applied Mathematics and Com-

puter Sciences, Faculty of Science. He teaches courses in statistics to students in the Faculty of Science, the Faculty of Pharmaceutical Science and the Masters program in Statistical Data Analysis. He did postdoctoral research at the Harvard School of Public Health and Ghent University. His current research focuses mainly on mediation analysis and estimation of the causal effect of time-varying exposures in longitudinal studies.

## Course prerequisites

- Participants are expected to be familiar with the basic principles of statistical inference and of linear regression analysis.

Longitudinal studies, employing repeated measurement of subjects over time, play a prominent role in many fields. In the biomedical and pharmaceutical sciences for example, they may provide valuable insights into both the development and persistence of disease and those factors that can alter the course of disease development. In the social sciences, longitudinal studies can be used to examine thoughts, feelings, physiology and behavior in their natural contexts and can show the unfolding of a temporal process.

In this course, we will offer a systematic presentation of modern methods for the analysis of such studies, with an emphasis on practical applications in biomedical research and in psychology.

The course will begin with a discussion of the usefulness of longitudinal studies over cross-sectional studies and the limitations of standard regression methods for analyzing longitudinal studies.

The course will then cover the **general linear mixed model** for the analysis of continuous responses. A wide range of examples drawn from real-world studies will be used to illustrate the methods for estimating models **in SAS and R** and for interpreting model coefficients.

The regression modeling will cover model building for the

mean and covariance structure to choose parsimonious models, **predictions of patient-specific profiles** and verification of goodness-of-fit of the model.

In the final lecture, we will briefly discuss specialized topics, including the problem of **missing data** in longitudinal studies, adjustment for baseline responses and evaluation of the effect of time-varying exposures.

All methods will be illustrated with annotated computer output from SAS and R. **Hands-on** computer sessions will help practice the principles to which one is exposed in this course.

## Exam

- Participants can, if they wish, take part in an exam. A certificate from Ghent University will be issued to participants with a university degree at the bachelor level or an equivalent degree upon succeeding in this test.
- To qualify for reimbursement from the UGent Doctoral Schools one must attend all classes and pass the exam. Visit the ICES website and your DS website for further information.

## Course material

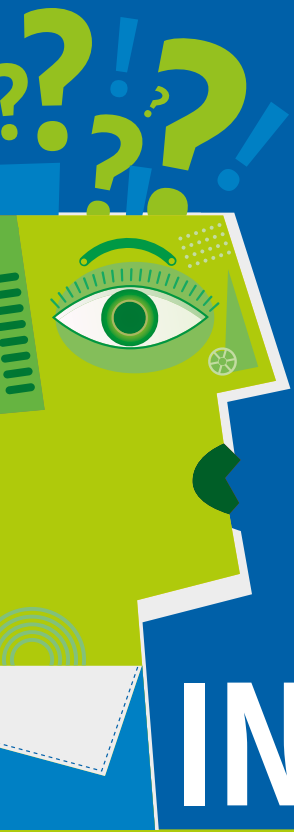
- Copies of lecture notes.
- Recommended handbook (optional): "Applied Longitudinal Analysis", G.M. Fitzmaurice, N.M. Laird and J.H. Ware, 2<sup>nd</sup> ed. (2011), John Wiley and Sons, ISBN 978-0470744611.

## Fees

- The registration fee amounts to 800 EUR. Reduced prices apply to students and participants of nonprofit and public services. These prices are available at the ICES website.
- The book is optional and can be bought at the additional cost of 120 EUR. Please indicate this clearly on the registration form.
- The examination fee is 30 EUR.

## Dates and venue

- April 11, 14, 18, 21, 25 and 28, 2016 from 5.30 pm to 9 pm. Each lecture is followed by a hands-on practical session.
- Faculty of Science, Campus Sterre, Krijgslaan 281, Building S9, Ghent.

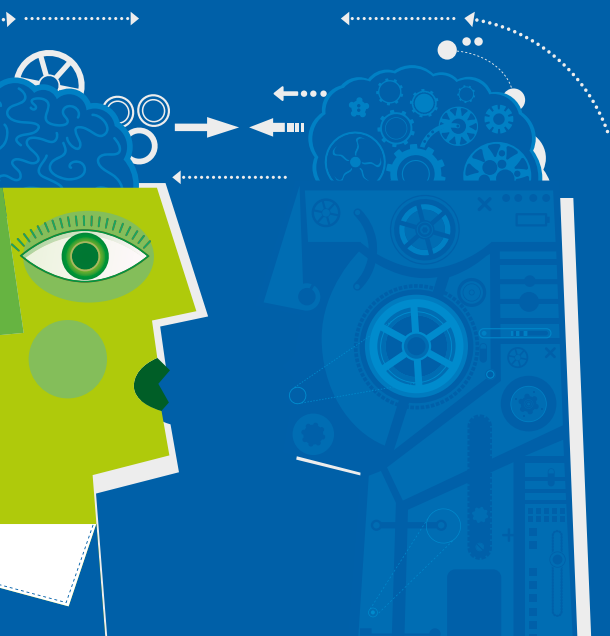


PRACTICAL  
**INFORMATION**

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Please use the registration form on our website:  
[www.ipvw-ices.UGent.be](http://www.ipvw-ices.UGent.be).

- Your registration is valid from the moment you receive an e-mail confirmation from ICES. If you have not received this mail within a week, please contact ICES to double check. From the moment the confirmation e-mail is sent the payment and cancellation conditions are in effect.
- The registration fee covers tuition, some or all of the course materials, use of auditoria and PCs, drinks and sandwiches. Reduced prices apply to students and participants of nonprofit and public services. These prices are available on the ICES website.
- The examination fee for each module that has an exam connected to it is 30 EUR.
- Visit the ICES website for further information on the payment and cancellation conditions, additional reductions for participants from the non-profit and private sector, support measures from the government, the Doctoral Schools.
- Besides statistical courses ICES offers courses in a range of scientific disciplines as well as further training for secondary school teachers (in Dutch).
- Stay informed about future courses through [www.ipvw-ices.UGent.be](http://www.ipvw-ices.UGent.be)



# IPVW:

VOOR LEERKRACHTEN  
EN VRIENDEN VAN  
DE WETENSCHAPPEN

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Het IPVV organiseert een divers palet aan opleidingen. Naast de cursussenreeks statistiek zijn ook andere modules gericht op onderzoekers in de industrie en academische instellingen, alumni en bij uitbreiding een breed geschoold publiek. Graag zetten wij twee nieuwere initiatieven extra in de kijker:

### **Bijscholingen voor Leerkrachten Wetenschappen**

Elk schooljaar biedt het IPVV een reeks bijscholingen aan voor leerkrachten die wetenschapsvakken of wiskunde geven. De samenstelling en het uitwerken van dit programma berust op een nauwe samenwerking tussen medewerkers van de faculteit Wetenschappen en de Specifieke Lerarenopleiding (SLO) van de Universiteit Gent. De focus ligt daarbij steeds op toepasbaarheid in de eigen lespraktijk.

Het aanbod wordt jaarlijks herzien en uitgebreid of gevarieerd, zodat de diverse wetenschapsdisciplines aan bod komen. Hierbij horen wij ook van u als leerkracht graag waar uw wensen en noden liggen m.b.t. bijscholing, zodat wij hierop in de mate van het mogelijke kunnen inspelen. Contacteer ons via [ipvw.ices@UGent.be](mailto:ipvw.ices@UGent.be).

Blijf op de hoogte van deze bijscholingen:

- [www.leerkrachtenwetenschappen.UGent.be](http://www.leerkrachtenwetenschappen.UGent.be):  
Onze website wordt regelmatig bijgewerkt met nieuwe bijscholingen.
- Schrijf je in op de IPVV-mailinglist en ontvang als eerste bericht over ons aanbod. Stuur een mailtje naar [listserv@lists.ugent.be](mailto:listserv@lists.ugent.be) met in de titel "subscribe wetenschappen"

### **Capita Selecta: actueel onderzoek binnen de Faculteit Wetenschappen**

Vraag je je als alumnus wel eens af welke onderzoeksprojecten nu lopen binnen de Faculteit Wetenschappen en welke toepassingen deze hebben in de maatschappij? In 2015-2016 laten wij onderzoekers uit de verschillende onderzoeksdisciplines aan het woord. Zij lichten hun onderzoek toe op een wetenschappelijke maar tegelijk begrijpbare manier, en nodigen u uit om na te praten bij een glas in een aangename setting.

Kom langs en ontdek de fascinerende nieuwe ontwikkelingen in de exacte wetenschappen! Blijf op de hoogte van deze voordrachten:

- Schrijf je in als alumnus via [www.ugent.be/alumnus/nl/databank](http://www.ugent.be/alumnus/nl/databank).





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