# Applied linear models

## Prof. Lucia Paci

***COURSE AIMS AND INTENDED LEARNING OUTCOMES***

The course focuses on normal linear models and generalized linear models employed to explain how a response variable relates to one or more explanatory variables. The aim of the course is to provide students with advanced knowledge in linear and generalized linear models from both theoretical and practical perspectives.

By the end of the course, students are expected to:

1. have acquired advanced knowledge of regression models used to investigate relationships between response and covariates, under the linear or generalized linear framework (*knowledge and understanding*);
2. be able to: provide a suitable description of the data; specify a normal linear regression model, estimate its parameters and test their significance; specify a generalized linear model, by combining a random component with a linear predictor with a proper link function; estimate and test the significance of the parameter of a generalized linear model (*applying knowledge and understanding*);
3. be able to perform variable selection procedures and identify relevant predictors; evaluate the goodness of fit of a model and to detect violations of model assumptions; interpret the results of an empirical analysis (*making judgements*);
4. be able to describe with an appropriate statistical language the assumptions behind a model, and to communicate the results of empirical findings using suitable tools (*communication skills*);
5. be able to autonomously develop and implement linear and generalized linear models to analyse real data (*learning skills*).

***COURSE CONTENT***

* *Exploratory analysis*: plotting data, transformations;
* *Basic framework for linear models*: model specification and assumptions; parameter estimation (least squares and maximum likelihood methods); statistical inference for regression; inclusion of qualitative regressors;
* *Regression diagnostics*: definitions and properties of residuals; influential observations and leverage points; multicollinearity;
* *Variable selection procedures:* effects of model mispecification; stepwise methods;
* *Generalized linear models*: exponential families, linear predictor and link functions; maximum likelihood estimators; goodness of fit: the deviance of a model; residual analysis.

***READING LIST*** [[1]](#footnote-1)

Class notes, slides, papers, coding and further material will be posted on the University platform Blackboard.

Useful readings are:

* Faraway, *Linear Models with R*, 2nd edition, Chapman & Hall, 2014.
* J. Fox, *Applied Regression Analysis and Generalized Linear Models*, 3rd edition, Sage, 2016.
* S. Weisberg, *Applied Linear Regression,* 3rd edition, Wiley, 2005.

***TEACHING METHOD***

A blend of theoretical lectures, practical classes, discussion of case studies and lab sessions using R. Attending the lectures, active participation and ongoing personal study are strongly recommended.

***ASSESSMENT METHOD AND CRITERIA***

The assessment is based on two parts:

1. Written test: open-ended questions and exercises involving the content of the course and aiming at evaluating student’s knowledge according to the learning outcomes of the course;
2. Assignment: consists in a work-home data analysis project implemented in R and carried out individually by the student.

The final grade is equally based on the two parts.

***NOTES AND PREREQUISITES***

Students enrolling in this course are expected to know foundations of algebra, probability, data analysis, and statistical inference, i.e., the topics covered in the courses “Mathematical methods and probability” and “Statistical Inference” taught in the first term. Moreover, students are expected to be familiar with R statistical software.

In case the current Covid-19 health emergency does not allow frontal teaching, remote teaching will be carried out following procedures that will be promptly notified to students.

1. I testi indicati nella bibliografia sono acquistabili presso le librerie di Ateneo; è possibile acquistarli anche presso altri rivenditori. [↑](#footnote-ref-1)