COURSE DESCRIPTION
Statistical process control

SSD: STATISTICA (SECS-S/01)

DEGREE PROGRAMME: PRECISION LIVESTOCK FARMING (DG2)
ACADEMIC YEAR 2025/2026

COURSE DESCRIPTION

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GENERAL INFORMATION ABOUT THE COURSE

INTEGRATED COURSE: U7572 - Big data approach and analysis
MODULE: U7573 - Statistical process control
TEACHING LANGUAGE: INGLESE
CHANNEL:
YEAR OF THE DEGREE PROGRAMME: I
PERIOD IN WHICH THE COURSE IS DELIVERED: SEMESTER I
CFU: 5

REQUIRED PRELIMINARY COURSES

None

PREREQUISITES

There are no specific prerequisites. However, students are expected to have a familiarity with (very, very) basic mathematics and fundamental computer science competence.

LEARNING GOALS

The course aims to provide students with a broad overview of statistical methods and models that can be used to address real-life applications.
Exploratory data analysis and model building are employed, with particular emphasis on statistical techniques used in machine learning.
The course aims to provide students with specific skills for tackling real-world applications through case studies that actively involve individual students or groups.

Students will learn to navigate the R environment: open-source software widely used for data analysis and also adopted in other modules of the program. The emphasis on applying methodologies and interpreting results will help students appreciate the value of statistical tools in their study context.
Moreover, the course aims to provide students with an integrated overview of the potential applications of artificial intelligence (AI) in livestock farming, enhancing production efficiency, improving animal welfare, and promoting environmental sustainability. Focusing on data analysis from sensors, images, and management systems, students will acquire skills in the use of machine learning techniques (supervised and unsupervised learning for classification and regression tasks). The teaching approach will be practice-oriented, with case studies based on real-world scenarios and group project activities. Learning will be supported by open-source tools, with a particular focus on platforms and programming languages such as R and Python. Emphasis will be placed on understanding models, interpreting their outputs, and adapting AI solutions to the specific needs of the livestock sector.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

The training program aims to provide students with the fundamental concepts of statistics as applied to data analysis, statistical inference, and statistical modeling , as well as to assess the quality of the available data.
Students are expected to demonstrate an understanding of how each technique can be applied in various analytical contexts; they must also be able to interpret and describe data, methods, and results within an empirical study.

Applying knowledge and understanding

The training program is designed to develop the ability to understand the extent to which statistical tools can provide answers to empirical questions.
Students are expected to demonstrate the ability to assess whether a theoretical model has an empirical basis, given an appropriate dataset, and to understand the contribution that statistical analysis makes to the development and implementation of Artificial Intelligence models. They must also demonstrate the ability to analyze the relationship between variables, given a suitable dataset, and to critically evaluate the strength of an empirical study.

COURSE CONTENT/SYLLABUS

Introduction to R and RStudio. The logic of the R language. The RStudio environment. Managing the R/RStudio workspace. RStudio projects: creating and using an R project.
Types of variables.
Importing data into RStudio from the main sources. Commands for data management: organizing and selecting. Commands for modifying data structures: mutate, filter, and summary. Using group_by to obtain a summary for groups of observations.

Recoding a qualitative variable using mutate, recode, and if_else . Recoding a numeric variable using cut, cut_interval , cut_width , and cut_length .
The table function. Univariate frequency table. Bivariate frequency tables. Row and column profiles. Location indices: minimum, maximum, quantiles, mode, median, and mean. Variability indices: deviance, variance, standard deviation, and coefficient of variation. Skewness index.
Basic univariate graphical representations: barplot , histogram, boxplot, violinplot , dotplot , density plot.
Main bivariate graphical representations. Covariance and correlation. Graphical representation of correlation. The corrr package.
Regression: least squares method, interpretation of the regression coefficient, and goodness-of-fit index. The lm function for calculating linear regression in R. Association between two categorical variables: independence condition, theoretical frequency under independence, chi-square index and its normalization. Association between characters. Calculation in R.
Relational data: mutant joins, filter joins, and set operations. Sorted data. Pivot tables: pivot_longer and pivot_wider . Separating and merging. Missing values.
Data Clustering and Factorial Methods.
Reporting: markdown and RMmarkdown . Using external R code to prepare a statistical report. Dashboards in R: the flexdashboard package. Dynamic reporting in RMarkdown .

READINGS/BIBLIOGRAPHY

Introduction to Statistics and Data Analysis
With Exercises, Solutions and Applications in R (Second Edition)
Part I + Appendix (introduction to R)
Available for free to the Students of the University of Naples Federico II at
https://link.springer.com/book/10.1007/978-3-031-11833-3
R Markdown at https://rmarkdown.rstudio.com/
Lecture notes made available by the teacher.

TEACHING METHODS OF THE COURSE (OR MODULE)

Traditional classroom teaching (60%); Active learning and case studies (40%)
The teacher will use a student- centered method; tutorials; Practical lessons, learning by doing method. The lessons will be supported by multimedia teaching material available to students on the teacher's website, after registering for the course.

EXAMINATION/EVALUATION CRITERIA

a) Exam type

- ☐ Written
- ☑ Oral
- ☑ Project discussion
- ☐ Other

In case of a written exam, questions refer to

☐ Multiple choice answers

☐ Open answers

☐ Numerical exercises

b) Evaluation pattern

The final grade will be weighted according to credits (CFUs) of each module and will be composed as follows:
"Statistical Process Control" module –5 CFUs: 62.5%;
"Livestock Farming through Artificial Intelligence" module –3 CFUs: 37.5%.

For the evaluation, the “Regulation for Guidelines for Exams Management” approved by the Didactic Coordination Committee of the Master's Degree in Precision Livestock Farming will be considered