Freie Universität Bozen
Libera Università di Bolzano
Università Liedia de Bulsan

Syllabus
Course description

Course title	Computer Application in Food Sciences
Course code	44741
Scientific sector	-
Degree	Food Sciences for Innovation and Authenticity
Semester	I
Year	1
Academic Year	2023/24
Credits	3
Modular	No

Total lecturing hours	30
Total lab hours	
Total exercise hours	
Attendance	**In-person attendance is recommended**, as it fosters direct interaction between the instructor and students. Students can ask questions, seek clarification, and participate in class discussions on topic such as coding in R, data analysis, and software usage, enhancing their understanding of the course material. **Lectures recording.** While in-person attendance is recommended, lectures are also recorded and offered online (recordings become available the day after the lecture's date) to accommodate students with scheduling or geographical constraints. However, students should be aware that in-person attendance is highly advantageous to make the most of the learning experience and develop practical skills in R and data analysis.
Prerequisites	The course is designed to accommodate students with varying levels of expertise. The instructor provides resources, pre-course materials, or optional introductory sessions to help students bridge any knowledge gaps and ensure a smooth learning experience for all participants. However, the following are some general prerequisites that would be helpful for students to have: ❖ Basic Understanding of Food Science: Students should have a foundational understanding of food science principles, food processing techniques, and the overall food industry. Familiarity with key terms and concepts in food science will make it easier for students to apply data analysis techniques in relevant contexts. ❖ Basic Mathematics and Statistics: A fundamental understanding of mathematics, including algebra

	and basic statistics, is important for data analysis and interpretation. Knowledge of concepts such as mean, standard deviation, and hypothesis testing will be beneficial. ❖ Computer Literacy: Basic computer literacy, including file management, navigating software, and understanding data formats, is essential for working with R and RMarkdown. Familiarity with spreadsheets and data entry would be advantageous. ❖ Familiarity with R: While the course is designed as an introduction to R, some prior exposure to R or another programming language would be helpful. Students with some experience in data analysis and coding will have a smoother transition into the course. ❖ Understanding of Research Methodology: Familiarity with research methodologies, experimental design, and data collection that are normally acquired during the writing of the Bachelor thesis will aid students in understanding the context and applications of data analysis in food science research. ❖ Statistical Software: Familiarity with statistical software (e.g., MS Excel or similar) would be beneficial but not mandatory. Some students may have used other statistical tools, which can provide a helpful perspective when learning R.
Course page	

Specific educational objectives	The specific educational objectives of the course "Computer Applications in Food Processing" are designed to equip students with practical skills and knowledge that will enable them to effectively apply data analysis and programming techniques in food science. The expected specific educational objectives include: ❖ Proficiency in R: By the end of the course, students should be proficient in using the R programming language for data manipulation, statistical analysis, and data visualization. They should be able to write and execute R scripts to solve food science-related problems. ❖ Understanding of Data Visualization: Students should gain a solid understanding of data visualization techniques using R. They should be able to create various types of charts and graphs to visually represent and communicate food science data effectively. ❖ Reproducible Research Practices: Students should be familiar with the concept of reproducible

	research and be able to use RMarkdown to create dynamic and interactive reports that document their data analysis processes. ❖ Application of Statistical Methods: Students should be able to apply statistical methods and tests in R to analyze food science data. They should understand how to select appropriate statistical techniques for different types of data and research questions. ❖ Data-Driven Decision-Making: Students should develop the ability to make data-driven decisions in food science by applying statistical analysis and data visualization to draw meaningful insights and conclusions. ❖ Case Study Application: Through the case studies, students should gain practical experience in applying R and data analysis techniques to real-world food science problems. They should be able to identify and address quality control, authenticity, innovation, and optimization challenges. ❖ Critical Thinking and Problem-Solving: The course should foster students' critical thinking and problem-solving skills by encouraging them to analyze complex food science data, identify patterns, and propose evidence-based solutions. ❖ Interpretation and Communication of Results: Students should be able to interpret and communicate the results of their data analysis effectively. They should understand how to present findings in a clear and concise manner, suitable for various audiences. ❖ Collaborative Skills: Through case studies and group activities, students should develop teamwork and collaborative skills, enabling them to work effectively in multidisciplinary teams on food science projects. ❖ Application in Food Industry: Students should understand how to apply the skills and knowledge gained in the course to real-world scenarios in the food industry. They should be aware of the relevance and impact of data-driven decision-making in food processing, quality control, and product development.

Lecturer	Matteo Scampicchio, matteo.scampicchio@unibz.it
Scientific sector of the lecturer	AGR/15
Teaching language	English
Office hours	Monday, 13-14 or previous appointment
Teaching assistant ***(if any)***	

List of topics covered	The list of topics covered in the course "Computer Applications in Food Processing" can be outlined as follows: **1. Introduction to R and Reproducible Research** ❖ Introduction to R programming language ❖ R environment setup and installation ❖ RStudio overview and usage ❖ Basic R syntax and data structures **2. Data Visualization with R** ❖ Data visualization principles and best practices ❖ Creating basic plots ❖ Customizing plots ❖ Visualizing distributions and trends ❖ Creating interactive and dynamic plots using Shiny **3. Reproducible Research with RMarkdown** ❖ Introduction to RMarkdown and its features ❖ Markdown syntax for text formatting ❖ Embedding R code chunks in RMarkdown documents ❖ Rendering RMarkdown documents into various formats (HTML, PDF, Word) ❖ Creating reports with RMarkdown **4. Case Study 1: Quality Control** ❖ Principles of quality control in food processing ❖ Control charts for monitoring process stability ❖ Statistical process control (SPC) techniques ❖ Implementing control charts in R for quality assurance **5. Case Study 2: Food Authenticity** ❖ Importance of food authenticity in the food industry ❖ Spectroscopic techniques for authenticity assessment ❖ Pattern recognition algorithms for detecting food fraud ❖ Using R for spectroscopic data analysis and pattern recognition **6. Case Study 3: Process Innovation** ❖ Process innovation in food processing ❖ Design of experiments (DOE) for process optimization ❖ Analyzing experimental data with R to optimize food processes ❖ Identifying critical process parameters for innovation **7. Case Study 4: Process Optimization** ❖ Methods for process optimization and response surface methodology ❖ Response surface modeling with R

	❖ Analyzing optimization results and identifying optimal conditions ❖ Sensitivity analysis and robustness in process optimization **8. Exam Simulation** ❖ Practice exam to assess students' understanding and application of R and data analysis techniques in food science ❖ Review of key concepts and problem-solving strategies ❖ Feedback and discussion of exam solutions ❖ Overall, the topics covered in this course provide students with a comprehensive understanding of R programming, data visualization, reproducible research practices, and their practical applications in food science. The case studies offer hands-on experience in applying data-driven decision-making to address real-world food science challenges, enhancing students' ability to leverage data analysis for innovation and quality improvement in the food industry.
Teaching format	The teaching format for the course "Computer Applications in Food Processing" is designed to enhance student engagement, learning outcomes, and practical application of knowledge. Here are some key elements that contribute to an effective teaching format: **1. Hands-On Approach**: The course should emphasize a hands-on learning approach, where students actively work with R and perform data analysis tasks. Practical exercises, case studies, and real-world projects allow students to apply concepts immediately and reinforce their understanding. **2. Interactive Lectures**: Demonstrations of R code and data visualization techniques will be done in real-time, making the learning process more dynamic. **3. Group Activities and Case Studies**: Incorporating group activities and case studies in the curriculum fosters collaboration and critical thinking. Students can work together to solve complex food science problems using R, encouraging teamwork and knowledge sharing. **4. Access to Resources**: Students will have access to resources such as R tutorials, coding examples, and relevant food science datasets enables self-learning and exploration beyond the classroom. **5. Flipped Classroom Approach**: Students receive in advance introductory materials before class and are stimulated to use class time for interactive discussions and problem-solving, rather than classical frontal lectures.

	6. Regular Feedback and Assessment: Regular quizzes are used to assess student progress and understanding. **7. Guest Speakers and Industry Insights**: where possible, guest speakers from the food industry will be invited to share their experiences with data-driven decision-making, providing valuable insights and practical applications of R in real-world scenarios. **8. Online Learning Platforms**: Online learning platforms (TEAMS) is used to support asynchronous learning and allow students to revisit lectures, access additional resources, and collaborate with peers. **9. Mentorship and Office Hours**: Regular office hours are planned to support individualized learning and address specific challenges. By combining these elements, the optimal teaching format for "Computer Applications in Food Processing" creates an immersive and supportive learning environment that empowers students to develop proficiency in R, apply data-driven approaches to food science challenges, and gain the skills needed to make data-informed decisions in the food industry.

Learning outcomes	**1. Knowledge and Understanding:** ❖ Understand the fundamentals of the R programming language and its applications in food science. ❖ Gain knowledge of data visualization techniques using R for effective representation of food science data. ❖ Comprehend the concept of reproducible research and its significance in the field of food science. ❖ Acquire knowledge of statistical methods and tests for analyzing food science data in R. **2. Applying Knowledge and Understanding:** ❖ Apply R programming skills to manipulate, clean, and preprocess food science datasets for analysis. ❖ Utilize data visualization techniques in R to explore patterns, trends, and relationships in food science data. ❖ Create reproducible research reports using RMarkdown to document data analysis processes and results. ❖ Apply statistical methods in R to make evidence-based decisions for quality control, authenticity assessment, process innovation, and optimization in food processing. **3. Making Judgments:** ❖ Evaluate and interpret data visualizations to draw meaningful insights and conclusions about food science processes and products.

	❖ Make informed judgments about the suitability of different statistical techniques for specific food science research questions. ❖ Apply critical thinking skills to identify and solve complex food science challenges using data-driven decision-making. ❖ Make judgments about the relevance and impact of data-driven approaches in food science for innovation, quality control, and product development. By the end of the course, students should have developed a strong foundation in R programming and data analysis, enabling them to apply these skills to address real-world food science problems. They will be able to make data-driven decisions and use statistical tools to improve food quality, authenticity, and innovation in the food processing industry. Additionally, students will have the ability to document and communicate their data analysis processes effectively using reproducible research practices. These learning outcomes will equip students with the necessary knowledge and skills to thrive in their future careers in food science and contribute to advancements in the field through data-driven approaches.

Assessment	The final assessment for the course "Computer Applications in Food Processing" consists of a comprehensive and practical examination that evaluates students' understanding and application of the concepts and skills covered in the course. The format for the final assessment includes: **1. Quiz (50 % of the total marks):** This is a written exam that include a mix of multiple-choice questions, short-answer questions related to R programming, data visualization, reproducible research practices, and statistical methods applied to food science. **2. Practical Data Analysis Project (50 % of the total marks):** Students receive a real-world dataset related to food processing, quality control, authenticity assessment, or process optimization. They will be required to perform data analysis using R to answer specific research questions or solve food science problems. The project should involve data cleaning, manipulation, visualization, and statistical analysis, demonstrating the application of R skills in food science contexts. **Scope of the assessment:** In both the written exam and the practical project, students are expected to interpret their findings and provide meaningful insights

	into the implications of their data analysis in the context of food science. **Timing:** The final assessment is designed to be completed within a time frame to allow students to demonstrate their abilities without undue time pressure. **Guidelines:** Clear instructions and guidelines are provided to students for the practical project to ensure consistency and clarity in the assessment process. During the course, several simulations will be offered to get trained for the exam format.
Assessment language	English
Evaluation criteria and criteria for awarding marks	**1. Quiz Evaluation Criteria:** Correctness of Answers: Marks are awarded based on the accuracy of students' answers to multiple-choice and short-answer questions related to R programming, data visualization, reproducible research, and statistical methods applied to food science. **2. Practical Data Analysis Project Evaluation Criteria:** **Data Preparation and Cleaning:** Marks are awarded for data cleaning and accuracy in the preparation of the R script. **Data Visualization:** Marks are given for the appropriateness of data visualizations in conveying insights from the dataset. **Statistical Analysis:** Students are evaluated on the appropriate application and accuracy of statistical methods in R to answer research questions and interpret results. **Discussion:** Marks are awarded based on students' ability to write research questions, interpret the findings from their data analysis and provide meaningful conclusions. **Code Quality:** Students are assessed on the quality of their R code, including organization, documentation, and reproducibility. **3. Overall Evaluation:** The final mark will be given as sum of the Quiz and the Practical Data Analysis Project **Award:** students may receive additional credits for demonstrating excellence in their answers.

Required readings	**1. R and RStudio:** ❖ R is a free, open-source statistical programming language, and RStudio is an integrated development environment (IDE) for R. Students should install both R and RStudio on their computers to practice coding and data analysis. ❖ R Download: https://cran.r-project.org/ ❖ RStudio Download: https://www.rstudio.com/products/rstudio/download/

	2. R for Data Science (R4DS) - Book: ❖ "R for Data Science" by Hadley Wickham and Garrett Grolemund is a fundamental resource for learning R programming for data analysis. It covers data manipulation, visualization, and modeling using R and the tidyverse packages. See the free online manual accompanying the book: https://r4ds.had.co.nz/ **3. RMarkdown:** ❖ RMarkdown Official Documentation: https://rmarkdown.rstudio.com/ ❖ RMarkdown is a critical component of the course, enabling reproducible research and report generation. Students should familiarize themselves with its basics before the course starts. See the official training manual: https://rmarkdown.rstudio.com/articles_intro.html **4. DataCamp - Online Learning Platform:** DataCamp offers interactive courses on R, data analysis, and data visualization. It provides an interactive learning experience and is a great complement to other learning materials. DataCamp Website: https://www.datacamp.com/ **5. R Graphics Cookbook - Book:** ❖ "R Graphics Cookbook" by Winston Chang is an excellent resource for learning how to create various visualizations using R. Website: http://www.cookbook-r.com/Graphs/ **6. RStudio Cheat Sheets:** ❖ RStudio provides cheat sheets on various R topics, including data visualization, data wrangling with dplyr, and more. These are handy references for quick guidance. RStudio Cheat Sheets: https://www.rstudio.com/resources/cheatsheets/ **7. GitHub:** ❖ GitHub hosts numerous repositories with R scripts and projects related to data analysis in various fields, including food science. Students can explore GitHub to find practical examples and real-world projects. **8. R-Bloggers:** ❖ R-Bloggers is a blog aggregator that compiles posts from various R blogs. It provides a wealth of articles on R programming, data analysis, and food science applications. Website: https://www.r-bloggers.com/ These minimal fundamental materials cover the basics of R programming, data analysis, and RMarkdown. By studying these resources before the course starts, students can get a solid foundation in R and be better prepared to dive into food science applications and case studies during the course.
Supplementary readings	For the course "Computer Applications in Food Processing," there are several excellent materials, references, websites, online tutorials, and books that can help students deepen their

understanding of R programming, data analysis, and its applications in food science. Here are some of the best resources:

1. **General Websites and Online Tutorials:**
   - RStudio's Official Website: https://www.rstudio.com/
   - R for Data Science (R4DS) by Hadley Wickham and Garrett Grolemund: https://r4ds.had.co.nz/
   - DataCamp's R Courses: https://www.datacamp.com/courses/free-introduction-to-r
   - R Graphics Cookbook by Winston Chang: http://www.cookbook-r.com/Graphs/
   - R-bloggers: https://www.r-bloggers.com/
   - Kaggle (Data Science Community with R Resources): https://www.kaggle.com/
2. **Websites and Online Tutorials for the use of R**
   - DataCamp: DataCamp offers interactive R courses for beginners to advanced users. Their hands-on approach allows learners to practice coding directly in the browser while learning essential R concepts and data manipulation techniques. Website: https://www.datacamp.com/courses/free-introduction-to-r
   - R for Data Science: This online book, also known as R4DS, is an excellent resource for beginners to learn data manipulation, visualization, and modeling using R and the tidyverse packages. Online Book: https://r4ds.had.co.nz/
   - Swirl: Swirl is an R package that provides interactive R programming lessons directly within the R console. It covers fundamental R concepts and is an interactive and engaging way to learn R.Website: https://swirlstats.com/
   - RStudio Education: RStudio's Education page offers a collection of tutorials, articles, and resources for learning R and data science using RStudio. Website: https://education.rstudio.com/
   - Codecademy: Codecademy offers a beginner-level R course that covers the basics of R programming, data types, functions, and data manipulation. Website: https://www.codecademy.com/learn/learn-r
   - Coursera: Coursera hosts various R-related courses, including introductory courses and specialization programs in data science with R. Website: https://www.coursera.org/
   - YouTube: YouTube is a vast resource for R tutorials and guides. Many R experts and educators create video tutorials that cover different aspects of R programming and data analysis. Example: R Programming Tutorial - For Beginners: https://www.youtube.com/watch?v=_V8eKsto3Ug

- RDocumentation: RDocumentation is a central repository of R packages and functions documentation. It's a valuable resource for understanding how to use different R functions.
  Website: https://www.rdocumentation.org/

3. Websites and Online Tutorials for Rmarkdown:

- RMarkdown Official Documentation: https://rmarkdown.rstudio.com/
- RMarkdown Cheat Sheet: This cheat sheet from RStudio provides a quick reference guide to the basic syntax and formatting options in RMarkdown. It's a handy resource to keep nearby while working on RMarkdown documents. RMarkdown Cheat Sheet: https://www.rstudio.com/wp-content/uploads/2015/02/rmarkdown-cheatsheet.pdf
- RMarkdown Official Gallery: RStudio maintains an official gallery that showcases various examples and templates of RMarkdown documents, including HTML, PDF, and Word output formats. Exploring the gallery can provide inspiration for your own RMarkdown projects. RMarkdown Gallery: https://rmarkdown.rstudio.com/gallery.html
- RMarkdown Tutorial by RStudio: This comprehensive tutorial by RStudio covers the basics of RMarkdown, including how to create different types of output formats, add code chunks, and include graphics and tables in your documents. RMarkdown Tutorial: https://rmarkdown.rstudio.com/lesson-1.html
- RMarkdown Cookbook: This resource provides practical examples and tips for using RMarkdown effectively. It covers advanced topics such as customizing output formats, creating dynamic documents, and integrating Shiny apps into RMarkdown. RMarkdown Cookbook: https://bookdown.org/yihui/rmarkdown-cookbook/
- DataCamp's RMarkdown Course: DataCamp offers an interactive online course on RMarkdown that covers the basics of RMarkdown, how to include code and graphics, and how to customize the appearance of your documents. DataCamp RMarkdown Course: https://www.datacamp.com/courses/reporting-with-r-markdown
- Blogdown: While not exclusively focused on RMarkdown, Blogdown is an R package that allows you to create and publish blogs and websites using RMarkdown documents. It's a useful resource if you're interested in sharing your data analyses and visualizations through blogs or web pages. Blogdown: https://bookdown.org/yihui/blogdown/
- RMarkdown Reference Guide: This guide provides detailed explanations of RMarkdown's syntax, including how to create tables, mathematical notation, and

interactive elements: https://www.rstudio.com/wp-content/uploads/2016/03/rmarkdown-reference.pdf

4. **Websites and Online Tutorials for Scientific Graphics with R:**
   - ❖ R Graphics: Base Graphics - DataCamp: DataCamp offers a free course that covers creating basic plots and customizing scientific graphics using R's base graphics system. Website: https://www.datacamp.com/courses/r-graphics-tutorial
   - ❖ R Base Graphics - Cookbook for R: The "Cookbook for R" website provides practical examples and recipes for creating various plots using R base graphics. Website: http://www.cookbook-r.com/Graphs/
   - ❖ Quick-R - Graphs: Quick-R is a website that offers a concise and easy-to-understand guide to creating various types of graphs using R's base graphics functions. Website: https://www.statmethods.net/graphs/
   - ❖ R Graph Gallery: The R Graph Gallery is a collection of examples showcasing different types of plots created using R base graphics. Website: https://www.r-graph-gallery.com/
   - ❖ Base Graphics - UCLA: UCLA's Institute for Digital Research and Education provides a tutorial on creating basic and advanced plots using R base graphics. Website: https://stats.idre.ucla.edu/r/seminars/r-graphs/
   - ❖ R Base Graphics - Data Visualization with R: This tutorial by Plotly provides a step-by-step guide to creating scientific visualizations using R's base graphics. Website: https://plotly.com/r/base-r-graphs-tutorial/
   - ❖ R Graphs - An Introduction: The University of Hawai'i at Manoa offers an introductory tutorial on creating graphs using R base graphics. Website: https://www.hawaii.edu/powerkills/DPGRAPH/R.HTM
   - ❖ R Base Graphics - Advanced - R Graphics: This tutorial, also from UCLA's Institute for Digital Research and Education, covers advanced techniques for customizing and enhancing R base graphics. Website: https://stats.idre.ucla.edu/r/seminars/advanced-r-graphics/
5. **Websites and Online Tutorials for Statistical Analysis with R:**
   - ❖ Quick-R - Statistics: Quick-R is a comprehensive website that covers a wide range of statistical techniques and how to perform them using R. It includes tutorials and examples for basic and advanced statistical methods. Website: https://www.statmethods.net/stats/index.html

- R for Data Science: While this online book is primarily focused on data manipulation and visualization, it also includes sections on statistical modeling and inference with R. Online Book: https://r4ds.had.co.nz/
- R Tutorial - Learn the Basics of Statistical Computing: This tutorial by DataCamp provides an introduction to R and covers the basics of statistical analysis, including hypothesis testing and regression. Website: https://www.datacamp.com/community/tutorials/tutorial-r
- Statistics with R - Coursera: Coursera offers various courses on statistics with R, including topics like inferential statistics, regression analysis, and multivariate statistics. Website: https://www.coursera.org/
- R Programming - Introduction to Statistics: This tutorial by Guru99 covers the basics of statistical concepts and how to perform statistical analysis in R. Website: https://www.guru99.com/r-statistics.html
- R Inferential Statistics - DataCamp: DataCamp's course on inferential statistics with R provides an in-depth look at hypothesis testing, confidence intervals, and p-values. Website: https://www.datacamp.com/courses/inferential-statistics-in-r
- R Graphs - An Introduction: Though the primary focus is on creating graphs, this tutorial also covers basic statistical concepts essential for data visualization in R. Website: https://www.hawaii.edu/powerkills/DPGRAPH/R.HTM
- R Statistics Blog - R-Bloggers: R-Bloggers is a blog aggregator that compiles posts from various R blogs. It offers numerous articles and tutorials on various statistical topics using R. Website: https://www.r-bloggers.com/
- Introduction to Statistics in R - YouTube: YouTube hosts a variety of video tutorials on statistical analysis using R, which can be helpful for visual learners. Example: https://www.youtube.com/watch?v=YHBmMzr-3i4

6. Books:

- "R Graphics Cookbook" by Winston Chang: This book provides practical examples and recipes for creating visualizations in R using ggplot2.
- "R for Data Science" by Hadley Wickham and Garrett Grolemund: This book is a comprehensive guide to data manipulation, visualization, and analysis using R and the tidyverse packages.
- "Cookbook for R" by Winston Chang: This book offers solutions to common data analysis challenges in R, including data manipulation, plotting, and statistical methods.
- "Data Science for Business" by Foster Provost and Tom

	Fawcett: Although not focused solely on R, this book covers how data science can be applied to business problems, which can be relevant for the food industry. **7. Journals and Research Papers:** ❖ "Journal of Food Engineering" - This journal covers research articles related to food processing and engineering, where R might be used for data analysis and modeling. ❖ "Food Chemistry" - This journal publishes papers on various aspects of food chemistry, and some researchers might use R for data analysis and visualizations in their studies. **8. GitHub Repositories:** ❖ GitHub hosts numerous repositories with R scripts and projects related to food science and data analysis. Students can explore repositories and learn from the code shared by other researchers. *Note: we recommend to explore these resources based on the students specific interests and the topics covered in the course. Students are encouraged to use online tutorials and hands-on practice with real datasets to strengthen their R programming skills and apply them to food science applications.*