Introduction to Machine Learning with applications (18 hours, 12 CFU)

Lecturers: Luigi Biagini

Objective: The objective of this course is to equip economists with practical machinelearning skills tailored to economic applications, particularly in the field of agricultural economics. Participants will learn to apply advanced machine learning techniques using R to analyse and interpret economic data, improve decision-making processes, and enhance predictive modelling capabilities in real-world economic contexts. By the end of the course, attendees will be able to independently implement machine learning models to address complex economic problems and derive actionable insights from data.

Program: The program is organised in 5 days of 3 hours each divided in 1,5 hours of theory and 1,5 hours of practical exercise. The course is hybrid, and a link for connection will be provided to students who are not able to join in person.

Exam: Short presentation of one of the homework assignments - Collection of homework - After two weeks at the end of the course

Day	Hour	Description	Lecturer	Language	Date

1	3	**Introduction to Machine Learning and R**
		Theory (1,5 hours)
		▪ Introduction to Machine Learning: Concepts and Importance in Economics:
		  o Definition and importance
		  o Key differences between traditional econometrics and machine learning: prediction vs Inference, Flexibility vs Interpretability, Goodness-of-fit vs Overfitting
		▪ Supervised vs. Unsupervised Learning
		▪ Setting in ML: Hyperparameters
		▪ Limitations and failures of ML
		Applications (1,5 hours)
		▪ Machine learning in economics: a literature review
			Luigi Biagini	English	Gen 2025

2	3	**Regularisation Methods** *Theory (1,5 hours)* ▪ Ridge, Lasso and Elastic Net Regression ▪ Handling Multicollinearity in Economic Data ▪ Importance of Regularization in Economic Models ▪ Metrics in Shrinkage: Deviance, RMSE, MAE, Pseudo R^2. *Application (1,5 hours)* ▪ Case Study: Using LASSO in a case study in economics. Implications and comments. ▪ Home Work Exercise: Using LASSO or RIDGE and comment on outcomes in an economic case study	Luigi Biagini	English	Gen 2025
3	3	**Discriminant Analysis** *Theory (1,5 hours)* ▪ Introduction to Classification Methods	Luigi Biagini	English	Gen 2025

		o Logistic Regression o Nearest Neighbor o Support Vector Machine ▪ Boosting and Shapley values ▪ Evaluation metrics: Accuracy, Precision, Confusion Matrix, AUC, ROC, Pseudo R^2 *Application (1,5 hours)* ▪ Case Study: Implementing Discriminant Analysis in an economics case study. Implications and comments. ▪ Home Work Exercise: Application of Discriminant Analysis and comment on outcomes in an economic case study			
4	3	**Tree Modeling** *Theory (1,5 hours)* ▪ Introduction to Tree Modeling ▪ Random Forest ▪ Boosting *Application (1,5 hours)* ▪ Case Study: Using tree modelling in an economics case study. Implications and comments. ▪ Homework Exercise: Using a Tree Modeling and comment on outcomes in an economic case study	Luigi Biagini	English	Gen 2025
5	3	**Artificial Neural Network** *Theory (1,5 hours)* ▪ Introduction of Artificial Neural Network ▪ Type of Artificial Neural Network and its application: Little introduction of Convolution Neural Network and Recurrent Neural Network *Application (1,5 hours)* ▪ Case Study: Using an Artificial Neural Network in an economics case study . Implications and comments. ▪ Homework Exercise: Using a Neural Network and comment on outcomes in an economic case study			

Language: English
Teaching method: Lectures and Homework
Period: January 2025