UAB Universitat Autònoma de Barcelona	Methodological Advances Code: 104866 Credits: 6	2026/2027

Degree programme	Type	Course
Applied Statistics	OP	4

Contact lecturer

Name : Víctor Navas Portella

Email : victor.navas@uab.cat

Teaching staff

Rosario Delgado De la Torre

Amanda Fernandez Fontelo

Group languages

You can consult this information at the end of the document.

Prerequisites

- First-year courses, as well as Numerical Methods and Optimization.
- Unsupervised Learning
- Machine Learning 1
- Machine Learning 2
- Modeling Complex Data

Objectives

The main objective is to enable the student to:

- Probabilistic Classifiers: Evaluate and calibrate probabilities predicted by models for decision-making, avoiding reducing them to simple labels (hard prediction).
- Advanced Deep Learning: Extend the use of neural networks to unstructured data using attention mechanisms and generative models.
- Interpretability: Provide transparency to models through explainability techniques and bias analysis.

Learning outcomes

- CM09 (Assess the suitability of the models with the correct use and interpretation of indicators and graphs.) Assess the suitability of the models with the correct use and interpretation of indicators and graphs.
- KM12 (Provide the experimental hypotheses of modelling, considering the technical and ethical

implications involved.) Provide the experimental hypotheses of modelling, considering the technical and ethical implications involved.
- SM12 (Interpret the results obtained to formulate conclusions about the experimental hypotheses.) Interpret the results obtained to formulate conclusions about the experimental hypotheses.
- SM13 (Compare the degree of adjustment between diverse statistical models.) Compare the degree of adjustment between diverse statistical models.
- SM14 (Use graphs to visualise the fit and suitability of the model.) Use graphs to visualise the fit and suitability of the model.

Contents

1. Block 1. Reliability and Calibration of Probabilistic Classifiers
2. Block 2. Advanced Deep Learning Models
3. Block 3. Interpretability and Explainability in Machine Learning Models

Learning activities and methodology

Title	Hours	ECTS	Learning outcomes
Classroom tasks	6	0.24	CM09, KM12, SM12, SM13, SM14
Study	96	3.84	CM09, KM12, SM12, SM13, SM14
Evaluation	6	0.24	CM09, KM12, SM12, SM13, SM14
Lectures	36	1.44	CM09, KM12, SM12, SM13, SM14

The course is organized into 3 clearly distinct modules of 14 hours each. The teaching methodology combines:

- Theory Sessions: Lecture-based classes covering the fundamentals, including some practical tips and demonstrations.
- Problem Sessions: Exercises designed to understand and consolidate the knowledge introduced in the theory sessions.
- Practical Sessions: Hands-on work directly on the computer to apply the concepts.

Depending on the specific block of the course, the following programming languages will be used:

- R
- Python

Annotation: within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Assessment

Continuous assessment activities

Title	Weight	Hours	ECTS	Learning outcomes

Continuous Assessment Tasks - Block 2	1/3	2	0.08	CM09, KM12, SM12, SM13, SM14
Continuous Assessment Tasks - Block 1	1/3	2	0.08	CM09, KM12, SM12, SM13, SM14
Continuous Assessment Tasks - Block 1	1/3	2	0.08	CM09, KM12, SM12, SM13, SM14

Continuous Assessment

The final grade for the course will be determined by the assessment of 3 independent blocks.

- Weighting: Each block carries equal weight in the final grade (1/3 each).
- Passing requirements: To pass the course via continuous assessment, the following conditions must be met:
- The average grade across all blocks must be equal to or higher than 5.0.
- At least two blocks must have a grade equal to or higher than 5.0, and the remaining block must have a grade equal to or higher than 3.5.
- Resit exam: If the student does not meet the passing requirements, they are entitled to take a resit exam for those specific blocks in which they obtained a grade lower than or equal to 5.

Single Assessment

Students will be assessed on the entire course content in a single final exam, which will be divided into sections corresponding to each block.

- Weighting: Each of the 3 blocks carries equal weight (1/3 each) within the exam grade.
- Passing requirements:
- The average grade of the assessment exam must be equal to or higher than 5.0.
- At least two of the blocks making up the exam must have a grade equal to or higher than 5.0, and the remaining block must have a grade equal to or higher than 3.5.
- Resit exam: If the student does not meet the passing requirements, they are entitled to take a resit exam for those specific blocks in which they obtained a grade lower than or equal to 5.

In this course, the use of Artificial Intelligence (AI) technologies is permitted as an integral part of project development, provided that the final outcome reflects a significant contribution from the student in terms of analysis and personal reflection. Students must clearly identify which parts have been generated using this technology, specify the tools employed, and include a critical reflection on how these tools have influenced both the process and the final result of the activity. A lack of transparency regarding the use of AI will be considered a breach of academic honesty and may lead to a penalty on the activity's grade, or more severe sanctions in serious cases.

Any irregularity committed during an assessment activity (academic fraud, plagiarism, or unauthorized use of AI, unless expressly permitted in the course guide) that could lead to a significant variation in the grade will result in a score of 0 for that specific activity. If the course guide specifies that a minimum grade in that assessment activity is an essential requirement to pass the course, or if multiple irregularities occur across different assessment activities within the same course, the final grade for the course will be 0. Furthermore, disciplinary proceedings may be initiated against any student who commits such irregularities.

Bibliography

- Gneiting, T., Raftery, A.E. (2007) Strictly proper scoring rules, prediction, and estimation. Journal of the American Statistical Association 102 (477), 359-378. https://sites.stat.washington.edu/raftery/Research/PDF/Gneiting2007jasa.pdf

- Niculescu-Mizil, A., Caruana, R. (2005) Predicting Good Probabilities with Supervised Learning. Proceedings of the 22nd International Conference on Machine Learning-ICML'05, Bonn, 7-11 August 2005, 625-632. https://doi.org/10.1145/1102351.1102430
- Guo, C., Pleiss, G., Sun, Y., Weinberger, K.Q. (2017). On Calibration of Modern Neural Networks. Proceedings of the 34th International Conference on Machine Learning, in Proceedings of Machine Learning Research 70:1321-1330 https://proceedings.mlr.press/v70/guo17a.html
- Prince, S. (2023) Understanding Deep Learning, https://udlbook.github.io/udlbook/
- Geron, A. (2019) Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow (O'Reilly)
- Friedman, J. H. (2001). Greedy Function Approximation: A Gradient Boosting Machine. *The Annals of Statistics*, *29*(5), 1189-1232. http://www.jstor.org/stable/2699986
- Goldstein, A., Kapelner, A., Bleich, J., & Pitkin, E. (2015). Peeking Inside the Black Box: Visualizing Statistical Learning With Plots of Individual Conditional Expectation. *Journal of Computational and Graphical Statistics*, *24*(1), 44-65. https://doi.org/10.1080/10618600.2014.907095
- Daniel W. Apley, Jingyu Zhu, Visualizing the Effects of Predictor Variables in Black Box Supervised Learning Models, *Journal of the Royal Statistical Society Series B: Statistical Methodology*, Volume 82, Issue 4, September 2020, Pages 1059-1086, https://doi.org/10.1111/rssb.12377
- Ribeiro, M.T., Singh, S., and, Guestrin, C. (2016) Why Should I Trust You?: Explaining the Predictions of Any Classifier. Proceedingf of the 22nd ACM SIGKDD International Conference on Knowledge Discovery and Data Minin (KDD'16). Association for Computing Machinery, New York, NY, USA, 1135-1144, https://dl.acm.org/doi/10.1145/2939672.2939778
- Lundberg, S.M., and, Lee, S.I. (2017). a unified approach to interpreting model predictions. Proceedings of the 31st International Conference on Neural Information Processing Systems (NIPS'17). Curran Associates Inc., Red Hook, NY, USA, 4768-4777. https://dl.acm.org/doi/abs/10.5555/3295222.3295230

Software

- R
- Python

Course groups and languages

The information provided is provisional until November 30. After this date, you will be able to consult the language of each group through this link. To access the information, you will need to enter the course CODE

Type of teaching	Group	Language	Semester	Shift
(TE) Theory	1	Catalan	second semester	afternoon
(PLAB) Practical laboratories	1	Catalan	second semester	afternoon