Universidad Rey Juan Carlos

TEACHING GUIDE

ARTIFICIAL INTELLIGENCE AND LEARNING

GRADO EN INGENIERÍA BIOMÉDICA (INGLÉS) (3º y 4º curso) (2374)

ACADEMIC YEAR 2026-27

Q2803011B UNIVERSIDAD REY JUAN CARLOS
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I.-Subject Identification	
Type	OBLIGATORIA
Teaching period	4 course, 1Q semester
Nº of credits	3
Language in wich the subject is taught	English

II.-Presentation

El desarrollo alcanzado en las Tecnologías de la Información y las Comunicaciones en las últimas décadas, ha traído consigo la recopilación y almacenamiento creciente de datos en ámbitos tan diversos como pueden ser marketing, salud o seguridad. La disponibilidad de grandes cantidades de datos hace necesaria la búsqueda de nuevos paradigmas de aprendizaje máquina, capaces de abordar el análisis automatizado de los mismos con la consiguiente extracción de información. Esta asignatura proporciona herramientas para conocer los principios fundamentales de las herramientas de aprendizaje estadístico, así como los pasos necesarios para abordar con éxito un problema de aprendizaje. Tras cursar esta asignatura, el estudiante será capaz de abordar problemas reales de ingeniería biomédica que se resuelven utilizando herramientas de inteligencia artificial y aprendizaje automático (artificial intelligence y machine learning). La asignatura combina sesiones teóricas con prácticas en el laboratorio de informática. Tanto las transparencias como la documentación relativa a las clases prácticas estarán accesibles a través del Aula Virtual de la asignatura antes de su utilización en las clases correspondientes. En la asignatura se hará uso de conceptos de “Álgebra”, “Cálculo”, “Fundamentos de Programación”, y “Probabilidad y Estadística”. También es recomendable haber cursado la asignatura "Idioma Moderno" (inglés). Nota sobre el material de estudio: las transparencias utilizadas en las clases teóricas son material de apoyo a la docencia presencial. El principal material de estudio del estudiante deben ser los apuntes tomados en clase, complementados con la consulta de las referencias bibliográficas

III.-Learning outcomes

CG01 . Analyze and synthesize problems related to biomedical engineering, solve them and communicate them efficiently.
CG02. Use computational and experimental tools for the analysis and quantification of biomedical engineering problems
CE03. Use state-of-the-art techniques in univariate and multivariate statistics, and rigorously propose new analyses in biomedical problems that cannot be addressed by standard methods of information analysis.
CE04. Solve mathematical problems that may arise in biomedical engineering by applying knowledge and concepts related to optimization.

- Key for degrees not adapted to RD 822/21: **CB** - basic competences, **CG** - generic competences, **CE** - specific competences, **CT** - transversal competences.
- Key for degrees adapted to RD 822/21: **CON** - knowledge, **COM** - competences, **HAB** - skills.

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IV.-Contents

IV.A.-Syllabus

Unit 1. Introduction
1.1 Artificial intelligence and machine learning
1.2 Data collection, data cleaning, and pre-processing
1.3 Supervised and unsupervised learning
1.4 Selection and evaluation of machine learning models
1.5 Biomedical examples and applications
Unit 2. Parametric regression
2.1 Introduction. Cost function. Metrics in regression
2.2 Univariate and multivariate linear regression
2.3 Non-linear regression. Quadratic and multiplicative terms
2.4 Linear regression with regularisation. Ridge and Lasso
2.5 Biomedical examples and applications
Unit 3. Parametric classification
3.1 Introduction. Cost function. Metrics in classification.
3.2 Logistic regression
3.3 Logistic regression with regularisation
3.4 Biomedical examples and applications
Unit 4. Non-parametric methods
4.1. Introduction
4.2. k nearest neighbours
4.3. Decision Trees
4.4. Biomedical examples and applications
Unit 5. Unsupervised learning
5.1. Introduction. Clustering algorithms.
5.2. Partitional clustering. The k-means algorithm
5.3. Hierarchical clustering. Agglomerative techniques
5.4. Biomedical examples and applications

IV.B.-Training activities

Type	Title
Lectures	Lecture and analysis of scientific papers
Experimental and/or technological laboratories	Practical classes in the lab
Group work	Group projects that gradually include the course's concepts will be completed as the course is being developed.
Theoretical sessions	Theoretical session
Oral presentations	Oral presentation of the group project

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V.-Student workload	
Theoretical sessions	17
Resolution of exercises, problems, case studies, etc.	0
Practical sessions in experimental, technological and clinical laboratories, fieldwork, etc.	10
Tests and/or exams	3
Academic tutorials	20
Related activities: conferences, seminars, etc.	4
Preparation of theoretical sessions and self-study	10
Preparation of practical tasks, exercises, case studies, projects, etc.	12
Preparation for tests and/or exams	14
Total student workload	90

VI.-Methodology and academic programme		
Type	**Period**	**Content**
Group work	Week 10 to Week 15	Presentation of a project that will progressively include the concepts seen in Units 1, 2 and 3.
Theoretical sessions	Week 4 to Week 5	Practice of Unit 2. Putting into practice the theoretical contents of Unit 2 through the use of free software applications or those available on MyApps. The student will have the practice script before the beginning of the session.
Tests and/or exams	Week 14 to Week 16	Written test with all the contents taught in the subject
Academic tutorials	Week 1 to Week 15	Resolution of doubts.
Theoretical sessions	Week 1 to Week 14	Projects based on the analysis of real data will be carried out
Theoretical sessions	Week 1 to Week 2	Theory of Unit 1. Synchronous master class. The student will have visual support content, which can be used to prepare the content of each topic.

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Theoretical sessions	Week 3 to Week 4	Theory of Unit 2. Synchronous master class. The student will have visual support content, which can be used to prepare the content of each topic.
Theoretical sessions	Week 5 to Week 6	Theory of Unit 3. Synchronous master class. The student will have visual support content, which can be used to prepare the content of each topic.
Theoretical sessions	Week 7 to Week 8	Theory of Unit 4. Synchronous master class. The student will have visual support content, which can be used to prepare the content of each topic.
Theoretical sessions	Week 9 to Week 10	Theory of Unit 5. Synchronous master class. The student will have visual support content, which can be used to prepare the content of each topic.
Practical sessions	Week 6 to Week 7	Practice of Unit 3. Putting into practice the theoretical contents of Unit 3 through the use of free software applications or those available on MyApps. The student will have the practice script before the beginning of the session.
Practical sessions	Week 8 to Week 9	Practice of Unit 4. Putting into practice the theoretical contents of Unit 4 through the use of free software applications or those available on MyApps. The student will have the practice script before the beginning of the session.
Practical sessions	Week 10 to Week 11	Practice of Unit 5. Putting into practice the theoretical contents of Unit 5 through the use of free software applications or those available on MyApps. The student will have the practice script before the beginning of the session.
Practical sessions	Week 2 to Week 3	Practice of Unit 1. Putting into practice the theoretical contents of Unit 1 through the use of free software applications or those available on MyApps. The student will have the practice script before the beginning of the session.

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VII.-Assessment methods

The general assessment method is continuous as established in the *Regulation for the Assessment of Learning Outcomes* of Rey Juan Carlos University.
All the assessment systems established in the degree report must be employed, except for those that have a minimum weight of 0%, which can be used by professors in the academic years they consider relevant. Each assessment system may be applied through one or more assessment activities, consistent with the system. No assessment activity can exceed individually 60% of the overall grade for the subject.
The sum of non re-evaluable activities cannot exceed 40% of the overall grade for the subject and, in general, should not have an established minimum grade (except for practical activities in which, strictly speaking, the conditions of the ordinary call cannot be reproduced in the extraordinary call).
Those students who do not manage to pass the subject in the ordinary call, or do not attend this first call, may attend the extraordinary call only for failed re-evaluable assessment activities.
The distribution and characteristics of the assessment activities are described below.

VII.A.-Description and weight of the assessment activities

Ordinary Call: In this call, the following assessments will be carried out:

- **Final on-site exam of the course,** which is re-assessable and will include practical, theoretical-practical, and analytical questions related to all course topics (Topics 1, 2, 3, 4, and 5). This exam accounts for **60% of the final course grade. A minimum score of 5 out of 10 is required to pass the course.**
- **Submission and presentation of one group project.** This activity corresponds to the practical component of the course, is non-reassessable, and accounts for **30% of the final course grade.** It consists of a group project that must include the submission of the developed code, an explanatory video, and an oral presentation and defense. The submission deadline will be announced during the introductory course session and will be scheduled at least one week before the end of the course. The detailed timeline for this activity is provided in the “Methodology and Work Plan” section. Although the project will be carried out in groups, each student will receive an individual grade. To pass the course, students must obtai**n a minimum score of 5 out of 10.**
- **Individual on-site assessments based on the reading and analysis of scientific-technical documents related to the course content**: •
- The first document will cover concepts from Topics 1, 2, and 3, and will account for **5% of the final grade.**
- The second document will cover concepts from Topics 4 and 5, and will also account for **5% of the final grade**.
- These assessments are reassessable, and a **minimum average weighted score of 3 out of 10 is required to pass the course**. •

Extraordinary Call: If the course is not passed in the ordinary call, the following applies in the extraordinary call:

- The final exam grade will be retained if it is at least **5 out of 10.** If it is below 5, a new on-site final exam will be taken, including practical, theoretical-practical, and analytical questions covering all course topics (Topics 1 to 5), accounting f**or 60% of the final grade**. A **minimum of 5 out of 10 is required to pass.**
- The project grade obtained in the ordinary call is maintained.
- The scientific document assessment grade will be retained if the weighted average is **higher than 5 out of 10**. Otherwise, a final on-site exam covering practical and theoretical-practical questions related to the two documents will be administered, accounting for **10% of the final grade.** A minimum of 5 out of 10 is required to pass.

All assessments will consider clarity of expression and spelling accuracy, with corresponding penalties for spelling errors. To pass the course, **a minimum overall score of 5 out of 10 is required.**

Early Call:

- A final on-site exam covering practical, theoretical-practical, and analytical questions on all course topics (Topics 1 to 5), accounting for **60% of the final grade.** A minimum score of 5 out of 10 is required to pass.
- The project grade will be retained if the weighted average is higher than 5 out of 10. If not, a final on-site exam with questions related to course practices and projects will be taken, accounting for **40% of the final grade.** A minimum score of 5 out of 10 is required to pass.

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VII.B. Assessment of students with academic exemption from class attendance

Having Academic Exemption from Class Attendance (DAAC) does not imply that students are automatically exempt from participating in the continuous assessment activities or in the training activities of compulsory attendance as established in the teaching guide. Once the exemption has been granted, students must contact the subject's teaching staff, who will propose the adaptations he/she may consider relevant, as long as they guarantee the acquisition and adequate assessment of the learning goals established. Students must maintain adequate communication with the teaching staff so that they may provide information on the dates for training and assessment activities, if these are not established in the programme and available for students at the time of achieving the exemption.
Subject with possibility of academic exemption: Yes.

VII.C. Review of assessment activities

In accordance with the Regulation for the Assessment of Learning Outcomes of Rey Juan Carlos University.

VII.D.-Students with a disability or special educational needs

In order to guarantee equal opportunities, non-discrimination, universal accessibility and academic success, students with disabilities or especial education needs may request curricular adaptations to follow their studies. These adaptations will be provided by the Unit of Attention to People with Disabilities of Rey Juan Carlos University, in accordance with the regulation which regulates the service for the Attention of People with Disabilities at the University. This Unit will issue a report for curricular adaptations, so that students with disabilities or special education needs must contact the service (at e-mail discapacidad.programa@urjc.es) in order to provide relevant information for different educational alternatives.

VII.E.-Academic behaviour, academic integrity and honesty

Rey Juan Carlos University is fully committed to the highest standards of academic integrity and honesty, so studying at the URJC means assuming and subscribing to the values of integrity and academic honesty set out in the University's Ethical Code. To support this process, the University has Rey Juan Carlos University's Academic Conduct Regulation as well as different tools (anti-plagiarism, supervision...) that offer a collective guarantee for the full development of these essential values.

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VIII.-Teaching resources and materials
Basic bibliography
.Pattern classification. Duda, R. O., Hart, P. E., &Stork, D. G. John Wiley &Sons, 2012.
Hands-on machine learning with Scikit-Learn and TensorFlow: concepts, tools, and techniques to build intelligent systems. Géron, A. O'Reilly Media, Inc., 2017.
Deep learning. Goodfellow, I., Bengio, Y., &Courville, A. MIT press, 2016.
Machine learning: a probabilistic perspective. Murphy, K. P. MIT press, 2012.
The elements of statistical learning. Friedman, J., Hastie, T., &Tibshirani, R. New York: Springer series in statistics, 2001.
An introduction to statistical learning. James, G., Witten, D., Hastie, T., &Tibshirani, R. New York: springer, 2013.
Pattern recognition and machine learning. Bishop, C. M. Springer, 200
Consultation bibliography
Machine learning in action. Harrington, P. Manning Publications Co, 2012.
Python machine learning. Raschka, S. Packt Publishing Ltd, 2015.
Data Mining: Practical machine learning tools and techniques. Witten, I. H., Frank, E., Hall, M. A., &Pal, C. J. Morgan Kaufmann, 2016.
Learning from data. Abu-Mostafa, Y. S., Magdon-Ismail, M., &Lin, H. T. New York, NY, USA: AMLBook, 2012.

IX.-Professors	
Name and surname	CRISTIAN DAVID CHUSHIG MUZO
E-mail address	david.chushig@urjc.es
Department	Teoría de la Señal y Comunicaciones y Sistemas Telemáticos y Computación
Campus	Fuenlabrada
Category	Profesor/a Ayudante Doctor/a
Academic degree	Doctor
Person responsible for the subject	No
Tutorial timetable	Para consultar las tutorias póngase en contacto con el/la profesor/a a través de correo electrónico
Number of quinquennia	0
Number of sexennia	1
No. of positive evaluations by Docentia	0
Name and surname	CRISTINA SOGUERO RUÍZ
E-mail address	cristina.soguero@urjc.es

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Department	Teoría de la Señal y Comunicaciones y Sistemas Telemáticos y Computación
Campus	Fuenlabrada
Category	Catedrático/a de Universidad
Academic degree	Doctor
Person responsible for the subject	Yes
Tutorial timetable	Para consultar las tutorias póngase en contacto con el/la profesor/a a través de correo electrónico
Number of quinquennia	2
Number of sexennia	2
No. of positive evaluations by Docentia	3

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