ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

103000371 - Biomedical Informatics

DEGREE PROGRAMME

10AJ - Master Universitario En Inteligencia Artificial

ACADEMIC YEAR & SEMESTER

2025/26 - Semester 1

Index

Learning guide

1. Description

1.1. Subject details

Name of the subject	103000371 - Biomedical Informatics
No of credits	5 ECTS
Type	Optional/elective
Academic year ot the programme	First year
Semester of tuition	Semester 1
Tuition period	September-January
Tuition languages	English
Degree programme	10AJ - Master Universitario en Inteligencia Artificial
Centre	10 - E.T.S. De Ingenieros Informáticos
Academic year	2025-26

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Victor Manuel Maojo Garcia (Subject coordinator)	2102	victormanuel.maojo@upm.es	Tu - 12:30 - 15:30 W - 12:30 - 15:30
David Perez Del Rey	2104	david.perez.rey@upm.es	Sin horario.
Miguel Garcia Remesal	2206	miguel.garcia.remesal@upm.es	Tu - 11:00 - 14:00 Th - 11:00 - 14:00

* The tutoring schedule is indicative and subject to possible changes. Please check tutoring times with the faculty member in charge.

3. Skills and learning outcomes *

3.1. Skills to be learned

C3 - Ser capaces de concebir, desarrollar y validar nuevos sistemas que puedan aumentar la calidad de vida de las personas, y realizar, en contextos académicos y profesionales, innovaciones o avances tecnológicos que puedan hacer avanzar el estado del arte en áreas relacionadas con la Inteligencia Artificial. (To be able to conceive, develop, and validate new systems that can improve people's quality of life, and carry out, in academic and professional contexts, innovations or technological advances that can advance the state of the art in areas related to Artificial Intelligence). TIPO: Competencias.

C4 - Ser capaces de resolver problemas e integrar conocimiento en temas nuevos o escasamente definidos y en entornos multidisciplinares del área de la Inteligencia Artificial. (To be able to solve problems and integrate knowledge in new or loosely defined topics and multidisciplinary environments in the field of Artificial Intelligence). TIPO: Competencias.

C6 - Ser capaces de aplicar metodologías, procedimientos, herramientas y normas del estado del arte para la creación de nuevos componentes tecnológicos. (To be able to apply methodologies, procedures, tools, and standards from the state of the art for the creation of new technological components). TIPO: Competencias.

C7 - Ser capaces de construir nuevas hipótesis y modelos, evaluarlos y aplicarlos a la resolución de problemas en el área de la Inteligencia Artificial. (To be able to build new hypotheses and models, evaluate them, and apply them to problem-solving in the field of Artificial Intelligence). TIPO: Competencias.

C8 - Ser capaces de explicar e interpretar adecuadamente los resultados de la modelización y análisis de datos proporcionados por las técnicas de Inteligencia Artificial, utilizando plataformas existentes. (To be able to properly explain and interpret the results of modeling and data analysis provided by Artificial Intelligence techniques, using existing platforms). TIPO: Competencias.

C9 - Tener la capacidad de evaluar la aplicación de los algoritmos de Inteligencia Artificial, sus ventajas y limitaciones, y de seleccionar adecuadamente las técnicas apropiadas para un problema práctico o de investigación. (To have the ability to evaluate the application of Artificial Intelligence algorithms, their advantages and limitations, and to appropriately select the techniques suitable for a practical or research problem). TIPO: Competencias.

K7 - Conocer los avances más recientes en el ámbito de la Inteligencia Artificial. (To understand the latest advances in the field of Artificial Intelligence). TIPO: Conocimientos o contenidos.

S7 - Aplicar de manera efectiva y avanzada las técnicas de Inteligencia Artificial en contextos complejos y en constante evolución. (To effectively and advancedly apply Artificial Intelligence techniques in complex and constantly evolving contexts). TIPO: Habilidades o destrezas.

S8 - Identificar áreas de aplicación en las que se puedan utilizar las técnicas y métodos de la Inteligencia Artificial y aplicar los mismos de manera adecuada. (To identify application areas where Artificial Intelligence techniques and methods can be used and apply them appropriately). TIPO: Habilidades o destrezas.

3.2. Learning outcomes

RA115 - Los resultados del aprendizaje correspondientes a esta asignatura han quedado definidos en el apartado de competencias de este documento, señalando los que corresponden a conocimientos, habilidades y competencias propiamente dichas.

RA114 - RA202 - Los resultados del aprendizaje correspondientes a esta asignatura han quedado definidos en el apartado de competencias de este documento, señalando los que corresponden a conocimientos, habilidades y competencias propiamente dichas.

* The Learning Guides should reflect the Skills and Learning Outcomes in the same way as indicated in the Degree Verification Memory. For this reason, they have not been translated into English and appear in Spanish.

4. Brief description of the subject and syllabus

4.1. Brief description of the subject

An often-cited definition of the area has been proposed by Ted Shortliffe: The rapidly developing scientific field that deals with the storage, retrieval, and optimal use of biomedical information, data, and knowledge for problem solving and decision making. It accordingly touches on all basic and applied fields in biomedical science and is closely tied to modern information technologies, notably in the areas of computing and communications. Many areas have been established, including topics such as decision support systems, electronic health records, hospital information systems, data and text mining, information retrieval, bibliographic systems, medical imaging, etc. Over the last 20 years, new areas have been introduced, such as merging medical informatics with bioinformatics, into what is called biomedical informatics. Then, areas such as translational bioinformatics have emerged. Fundamental new topics include precision medicine, Web-based applications, the introduction of social networks, biomedical ontologies, semantic interoperability, Big Data research and others. We emphasize topics of biomedical informatics related to artificial Intelligence, such as ontologies, machine learning, text mining or knowledge-based systems.

Over the last years, particularly after the introduction of ChatGPT and other Large Language Models into the mainstream of AI, a strong need for ethical considerations of different aspects has appeared, enhanced by national and international organizations. We will analyze the limitations of those AI systems, their ethical considerations, and other related issues.

4.2. Syllabus

1. Introduction
    1.1. Biomedical informatics: the concept.
    1.2. Historical analysis of biomedical informatics development since the 50s.
    1.3. Differences among areas (Medical Informatics, Bioinformatics, Biomedical Engineering and Biotechnology).
    1.4. Future trends
2. Artificial Intelligence in Biomedicine
    2.1. Medical reasoning methods.
    2.2. Knowledge-based systems
        2.2.1. Information retrieval

2.2.2. Database integration

2.3. LLMs: applications and ethics

3. Medical Information Systems

3.1. Electronic Health records; concept and clinical contents

3.2. Vocabularies and standarsa

3.3. Real world data

4. Information extraction. Data and text mining

4.1. Theory, methods and applications

5. Schedule

5.1. Subject schedule*

Week	Type 1 activities	Type 2 activities	Distant / On-line	Assessment activities
1	**Introduction to biomedical informatics** Duration: 02:00 Lecture		**In principle, no classes will be virtual, unless there is an indication of the UPM about it** Duration: 00:00 Lecture	**Participation in teaching activities, in class and on-line** Individual work Progressive assessment Not Presential Duration: 00:00
2	**AI in medicine. Medical diagnosis and reasoning** Duration: 00:00 Lecture		**IN principle, no classes will be virtual, unless there is an indication of the UPM about it** Duration: 00:00 Lecture	**Participation in teaching activities, in class and on-line** Individual work Progressive assessment Not Presential Duration: 00:00
3	**Artificial Intelligence in medicine: knowledge based-systems** Duration: 02:00 Lecture		**IN principle, no classes will be virtual, unless there is an indication of the UPM about it** Duration: 00:00 Lecture	**Participation in teaching activities, in class and on-line** Individual work Progressive assessment Not Presential Duration: 00:00
4	**Artificial Intelligence in medicine: LLMs and ethics** Duration: 02:00 Lecture		**IN principle, no classes will be virtual, unless there is an indication of the UPM about it** Duration: 00:00 Lecture	**Participation in teaching activities, in class and on-line** Individual work Progressive assessment Presential Duration: 00:00
5	**Artificial intelligence in medicine: text mining and Natural Language Processing** Duration: 02:00 Lecture		**IN principle, no classes will be virtual, unless there is an indication of the UPM about it** Duration: 00:00 Lecture	**Participation in teaching activities, in class and on-line** Individual work Progressive assessment Not Presential Duration: 00:00
6	**Artificial intelligence in medicine: text mining and Natural Language Processing (II)** Duration: 02:00 Lecture		**IN principle, no classes will be virtual, unless there is an indication of the UPM about it** Duration: 00:00 Lecture	**Participation in teaching activities, in class and on-line** Individual work Progressive assessment Presential Duration: 00:00
7	**Biomedical Vocabularies and ontologies (I)** Duration: 02:00 Lecture		**IN principle, no classes will be virtual, unless there is an indication of the UPM about it** Duration: 00:00 Lecture	**Participation in teaching activities, in class and on-line** Individual work Progressive assessment Not Presential Duration: 00:00

8	**Biomedical vocabularies and ontologies (II)** Duration: 02:00 Additional activities		**IN principle, no classes will be virtual, unless there is an indication of the UPM about it** Duration: 00:00 Lecture	**Presentation of assignment** Individual presentation Progressive assessment Presential Duration: 02:00
9	**Electronic Health Records and Real World Data** Duration: 02:00 Lecture **Actividades transversales** Duration: 02:00 Additional activities		**IN principle, no classes will be virtual, unless there is an indication of the UPM about it** Duration: 00:00 Lecture	**Participation in teaching activities, in class and on-line** Individual work Progressive assessment Not Presential Duration: 00:00
10	**Database integration and semantic interoperability** Duration: 02:00 Lecture		**IN principle, no classes will be virtual, unless there is an indication of the UPM about it** Duration: 00:00 Lecture	**Participation in teaching activities, in class and on-line** Individual work Progressive assessment Not Presential Duration: 00:00
11	**Big data and database analysis** Duration: 02:00 Lecture **Actividades transversales** Duration: 02:00 Additional activities		**IN principle, no classes will be virtual, unless there is an indication of the UPM about it** Duration: 00:00 Lecture	**Participation in teaching activities, in class and on-line** Individual work Progressive assessment Not Presential Duration: 00:00
12	**Data analysis of real medical data** Duration: 02:00 Lecture		**IN principle, no classes will be virtual, unless there is an indication of the UPM about it** Duration: 00:00 Lecture	**Presentacion of assignment** Group work Progressive assessment Presential Duration: 02:00
13	**Biomedical standards (I)** Duration: 02:00 Lecture **Actividades transversales** Duration: 02:00 Additional activities		**IN principle, no classes will be virtual, unless there is an indication of the UPM about it** Duration: 00:00 Lecture	**Participation in teaching activities, in class and on-line** Individual work Progressive assessment Not Presential Duration: 00:00
14	**Biomedical standards (II)** Duration: 02:00 Lecture		**IN principle, no classes will be virtual, unless there is an indication of the UPM about it** Duration: 00:00 Lecture	**Participation in teaching activities, in class and on-line** Individual work Progressive assessment Not Presential Duration: 00:00
15	**Artificial Intelligence: applications** Duration: 02:00 Additional activities **Actividades transversales** Duration: 02:00 Additional activities		**IN principle, no classes will be virtual, unless there is an indication of the UPM about it** Duration: 00:00 Lecture	**Presentation of a classwork assignment** Individual presentation Progressive assessment Not Presential Duration: 02:00
16	**Final Summary** Duration: 02:00 Lecture		**IN principle, no classes will be virtual, unless there is an indication of the UPM about it** Duration: 00:00 Additional activities	**Review of concepts from the course** Problem-solving test Progressive assessment Presential Duration: 00:00

17				**Final examination (if the student was not able to complete the course assignments due to some justified reason).** Written test Global examination Not Presential Duration: 02:00

Depending on the programme study plan, total values will be calculated according to the ECTS credit unit as 26/27 hours of student face-to-face contact and independent study time.

6. Activities and assessment criteria

6.1. Assessment activities

6.1.1. Assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
1	Participation in teaching activities, in class and on-line	Individual work	No Presential	00:00	%	/ 10	
2	Participation in teaching activities, in class and on-line	Individual work	No Presential	00:00	%	/ 10	
3	Participation in teaching activities, in class and on-line	Individual work	No Presential	00:00	%	/ 10	
4	Participation in teaching activities, in class and on-line	Individual work	Face-to-face	00:00	%	/ 10	
5	Participation in teaching activities, in class and on-line	Individual work	No Presential	00:00	%	/ 10	
6	Participation in teaching activities, in class and on-line	Individual work	Face-to-face	00:00	%	/ 10	
7	Participation in teaching activities, in class and on-line	Individual work	No Presential	00:00	%	/ 10	
8	Presentation of assignment	Individual presentation	Face-to-face	02:00	33%	5 / 10	C3 C7 C8 C4 S8 K7 S7
9	Participation in teaching activities, in class and on-line	Individual work	No Presential	00:00	%	/ 10	
10	Participation in teaching activities, in class and on-line	Individual work	No Presential	00:00	%	/ 10	
11	Participation in teaching activities, in class and on-line	Individual work	No Presential	00:00	%	/ 10	
12	Presentacion of assignment	Group work	Face-to-face	02:00	33%	5 / 10	K7 S7 C6 S8

13	Participation in teaching activities, in class and on-line	Individual work	No Presential	00:00	%	/ 10	
14	Participation in teaching activities, in class and on-line	Individual work	No Presential	00:00	%	/ 10	
15	Presentation of a classwork assignment	Individual presentation	No Presential	02:00	33%	5 / 10	C4 C9 S8 K7 S7
16	Review of concepts from the course	Problem-solving test	Face-to-face	00:00	%	/ 10	

6.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
17	Final examination (if the student was not able to complete the course assignments due to some justified reason).	Written test	No Presential	02:00	100%	5 / 10	C3 C7 C8 C4 C6 C9 S8 K7 S7

6.1.3. Referred (re-sit) examination

No se ha definido la evaluación extraordinaria.

6.2. Assessment criteria

The number of assignments will be presented during the length of the course, 3 a priori. The capacity of learning and solving the different problems presented during the course will be evaluated by these assignments and presentations.

7. Teaching resources

7.1. Teaching resources for the subject

Name	Type	Notes
de la Calle, G., García-Remesal, M., Chiesa, S., de la Iglesia, D., and Maojo, V. ?BIRI: a new approach for automatically discovering and indexing available public bioinformatics resources from the literature?. BMC Bioinformatics. 2009 Oct 7; 10:320.	Bibliography	
Bernstam, E.V., Smith, J.W., and Johnson, T.R. ?What is biomedical informatics?? J Biomed Inform. 2010 Feb;43 (1):104-10.	Bibliography	
Open papers and journals in Internet and Pubmed (JAMIA, JBI, JMIR, Nature and Lancet groups, etc)	Bibliography	
Devices for online teaching,	Equipment	If they are necessary, depending on the course of the pandemic
Aliferis et al. Biomedical Informatics textbook	Bibliography	Free book https://link.springer.com/book/10.1007/978-3-031-39355-6

8. Other information

8.1. Other information about the subject

The attendance to the course is required and the student will be required to sign and participate everyday. This is a course that requires the participation of students. We strongly recommend students to take a different course if they cannot attend it for any reason (ERASMUS students, students working at this schedule, etc)