ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

203000032 - Semantic Technologies

DEGREE PROGRAMME

20BC - Master Universitario En Biologia Computacional

ACADEMIC YEAR & SEMESTER

2025/26 - Semester 1

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1. Description

1.1. Subject details

Name of the subject	203000032 - Semantic Technologies
No of credits	3 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	20BC - Master Universitario en Biologia Computacional
Centre	20 - Etsi Agronómica, Aliment. Y Biosistemas
Academic year	2025-26

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Maria Poveda Villalon (Subject coordinator)	3205	m.poveda@upm.es	M - 09:00 - 12:00 W - 09:00 - 12:00
Asuncion De Maria Gomez Perez	2211	asunciondemaria.gomez@upm.es	Sin horario.

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

3. Prior knowledge recommended to take the subject

3.1. Recommended (passed) subjects

The subject - recommended (passed), are not defined.

3.2. Other recommended learning outcomes

- programación, scripting (aunque no son indispensables)

4. Skills and learning outcomes *

4.1. Skills to be learned

CE02 - Utilizar sistemas operativos, programas y herramientas de uso común en biología computacional, así como, manejar plataformas de cómputo de altas prestaciones, lenguajes de programación y análisis bioinformáticos

CE03 - Analizar e interpretar bioinformáticamente los datos que se derivan de las tecnologías ómicas, y proponer soluciones bioinformáticas en relación a dichos datos.

CE05 - Utilizar herramientas de biología computacional para el análisis genómico, incluida la genómica comparativa y biología evolutiva.

CE10 - Conocimiento de las técnicas de representación del conocimiento reutilizables y modelos de razonamiento en entornos centralizados y distribuidos a utilizar en la resolución de problemas que impliquen conducta inteligente.

CG02 - Familiarizarse con el trabajo y los métodos de la Biología Computacional en condiciones reales, adquiriendo la capacidad de diseñar aplicaciones/experimentos de forma independiente y describir, cuantificar, analizar y evaluar críticamente los resultados obtenidos.

CG03 - Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios (o multidisciplinares) relacionados con el area de la Biología Computacional.

CT07 - Ser capaz de manejar las tecnologías de la información y comunicación en un contexto profesional.

4.2. Learning outcomes

RA42 - Conocer cómo las tecnologías semánticas pueden ser aplicadas a problemas asociados con la biología computacional

RA44 - Modelar protocolos de laboratorio para facilitar la reproducibilidad de experimentos.

RA43 - Modelar ontologías para la representación de datos y la realización de inferencias

RA75 - Generación de datos anotados semánticamente a partir de recursos existentes

* 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.

5. Brief description of the subject and syllabus

5.1. Brief description of the subject

In this course, students will understand how semantic technologies can be applied to many of the problems associated with computational biology, especially those related to accessing and publishing shared public and private databases, modeling shared ontologies that can be used for data representation and inference in the field, and the detailed description of laboratory protocols to ensure better reproducibility of scientific experiments in both wet labs and in-silico experiments. The course will provide the knowledge necessary for students to be able to apply these techniques and approaches to all of these problems.

En este curso los estudiantes comprenderán cómo las tecnologías semánticas pueden ser aplicadas para muchos de los problemas asociados a la biología computacional, especialmente aquellos relacionados con el acceso y publicación de bases de datos públicas y privadas compartidas, al modelado de ontologías compartidas que pueden ser utilizadas para la representación de datos y la realización de inferencias en el área, o la descripción

detallada de los protocolos de laboratorio para asegurar una mejor reproducibilidad de experimentos científicos en laboratorios húmedos así como en experimentos *in-silico*. Se proporcionarán los conocimientos para que los alumnos sean capaces de aplicar estas técnicas y enfoques para todos estos problemas.

5.2. Syllabus

1. Introduction to Semantic Technologies
    1.1. Subject introduction and presentation
    1.2. Fundamentals
2. Ontology representation basic languages and querying
    2.1. RDF(S)
    2.2. SPARQL
3. Methodologies for ontology development and expressive ontology representation languages
    3.1. Theoretical foundations
    3.2. Methodologies and techniques for ontology development
    3.3. Ontologies and description logics: OWL
    3.4. Most well-known ontologies in the domain of computational biology
4. Linked Data in computational biology
    4.1. Theoretical foundations
    4.2. Linked Data generation methodology
    4.3. Linked Data exploitation
    4.4. The most widely used Linked Datasets in computational biology

6. Schedule

6.1. Subject schedule*

Week	Type 1 activities	Type 2 activities	Distant / On-line	Assessment activities
1	**Theoretical lesson topic 1.** Duration: 02:00 Lecture			
2	**Theoretical lesson topic 2** Duration: 01:00 Lecture **Hands-on lesson topic 2** Duration: 01:00 Laboratory assignments			
3	**Theoretical lesson topic 2** Duration: 01:00 Lecture **Hands-on lesson topic 2** Duration: 01:00 Laboratory assignments			
4	**Theoretical lesson topic 2** Duration: 01:00 Lecture **Hands-on lesson topic 2** Duration: 01:00 Laboratory assignments			
5	**Theoretical lesson topic 3** Duration: 02:00 Lecture			
6	**Theoretical lesson topic 3** Duration: 02:00 Lecture			
7	**Theoretical lesson topic 3** Duration: 01:00 Lecture **Hands-on lesson topic 3** Duration: 01:00 Laboratory assignments			
8	**Theoretical lesson topic 3** Duration: 01:00 Lecture **Hands-on lesson topic 3** Duration: 01:00 Laboratory assignments			

9	**Theoretical lesson topic 3** Duration: 01:00 Lecture **Hands-on lesson topic 3** Duration: 01:00 Laboratory assignments			
10	**Theoretical lesson topic 3** Duration: 01:00 Lecture **Hands-on lesson topic 3** Duration: 01:00 Laboratory assignments			
11	**Theoretical lesson topic 4** Duration: 01:00 Laboratory assignments **Hands-on lesson topic 4** Duration: 01:00 Laboratory assignments			
12	**Hands-on lesson topic 4** Duration: 02:00 Laboratory assignments			
13	**Hands-on sessions and problem resolutions 1-4** Duration: 02:00 Laboratory assignments			
14	**Hands-on sessions and problem resolutions 1-4** Duration: 02:00 Laboratory assignments			
15	**Hands-on sessions and problem resolutions 1-4** Duration: 02:00 Laboratory assignments			
16				**Email submission of the ontology development assignment with examples of linked data. + Final project presentation (if done in groups, each student?s presentation may be graded individually).** Group presentation Progressive assessment Presential Duration: 02:00 **Partial assignments average** Group presentation Progressive assessment Not Presential Duration: 00:00
17				**In the global assessment, the student will submit an individual project consisting of: an ontology (60% of the final grade) and data generated in accordance with the ontology (40% of the final grade).** Individual work Global examination Not Presential Duration: 00:00

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.

7. Activities and assessment criteria

7.1. Assessment activities

7.1.1. Assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
16	Email submission of the ontology development assignment with examples of linked data. + Final project presentation (if done in groups, each student?s presentation may be graded individually).	Group presentation	Face-to-face	02:00	60%	1 / 10	CG02 CG03 CT07 CE02 CE03 CE05 CE10
16	Partial assignments average	Group presentation	No Presential	00:00	40%	1 / 10	CG02 CG03 CT07 CE02 CE03 CE10

7.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
17	In the global assessment, the student will submit an individual project consisting of: an ontology (60% of the final grade) and data generated in accordance with the ontology (40% of the final grade).	Individual work	No Presential	00:00	100%	5 / 10	CG02 CG03 CT07 CE02 CE03 CE05 CE10

7.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
In the extraordinary evaluation process, the student will submit an individual project consisting of: an ontology (60% of the final grade) and data generated in accordance with the ontology (40% of the final grade).	Individual work	Face-to-face	00:00	100%	5 / 10	CG02 CG03 CT07 CE02 CE03 CE05 CE10

7.2. Assessment criteria

Assessment will be based on the development of an individual project related to the course content and its presentation in class for evaluation. The project will consist of the development of ontologies to address a specific problem, their relation to laboratory protocols, or other topics, and their representation, as well as the presentation of data according to the developed ontologies.

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
A.Gómez-Pérez, M. Fernández, O. Corcho. Ontological Engineering. Ed Springer, 2003	Bibliography	
Poveda-Villalón, M., Fernández-Izquierdo, A., Fernández-López, M., & García-Castro, R. (2022). LOT: An industrial oriented ontology engineering framework. Engineering Applications of Artificial Intelligence, 111, 104755.	Bibliography	Ontology development methodology https://doi.org/10.1016/j.engappai.2022.104755

MC. Suarez-Figueroa, A. Gómez-Pérez, E. Motta, A. Gangemi. Ontology Engineering in a Networked World?. Springer 2012.	Bibliography	
http://moodle.upm.es/titulaciones/oficiales/course/view.php?id=4897	Web resource	
http://www.neon-project.org/	Web resource	
http://www.w3.org/TR/rdf-schema/	Bibliography	
http://www.w3.org/TR/rdf-sparql-query/	Bibliography	
http://www.w3.org/2004/OWL/	Bibliography	
https://lot.linkeddata.es/	Web resource	Ontology development methodology
Espinoza-Arias, P., Poveda-Villalón, M. & Corcho, O. Using LOT methodology to develop a noise pollution ontology: a Spanish use case. J Ambient Intell Human Comput (2019). https://doi.org/10.1007/s12652-019-01561-2	Bibliography	Paper showing how to use the methodology to develop an ontology.

9. Other information

9.1. Other information about the subject

Course activities will be organized on the Moodle platform. All materials will be made available through this platform.

Emails will be answered and questions resolved using teleconferencing systems during tutorial hours or in person.

The specific topics of the ontologies developed and the data generated may vary across different course editions, depending on students? interests. However, the most common themes are related to diseases and their treatments (SDG 3) and life sciences (SDG 14 and SDG 15).

Methodologies such as the "flipped classroom" will be used; however, these will not be implemented for an entire session, which is why they are not listed in the activities. The "learning by doing" technique will also be employed.

Las actividades del curso se organizarán en la plataforma moodle. Todos los materiales se pondrán disponibles en dicha platoforma.

Se responderán emails y se resolverán dudas, usando sistemas de teleconferencia o en persona, en los horarios de tutorias.

La temática concreta de las ontologías desarrolladas y los datos generados puede variar en las distintas ediciones de la asignatura, dependiendo del interés de los estudiantes, pero los temas más comunes están relacionados con las enfermedades y los medicamentos para tratarlas (ODS3) y ciencias de la vida (ODS14 y ODS15).

Se utilizarán metodologías como "flipped classroom" sin embargo no se utilizarán durante toda una sesión, por eso no están en las actividades. También se utilizará la técnica de "learning by doing".