ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

103000364 - Logic Programming

DEGREE PROGRAMME

10AJ - Master Universitario En Inteligencia Artificial

ACADEMIC YEAR & SEMESTER

2025/26 - Semester 1

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1. Description

1.1. Subject details

Name of the subject	103000364 - Logic Programming
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 *
Jose Francisco Morales Caballero	2101	josefrancisco.morales@upm.es	Sin horario.
Manuel De Hermenegildo Salinas (Subject coordinator)	2212	manuel.hermenegildo@upm.es	Sin horario.
M. Carmen Suarez De Figueroa Baonza	2201	mdelcarmen.suarezdefigueroa@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. 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.

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.

K5 - Conocer los métodos de representación del conocimiento y razonamiento aplicables al desarrollo de sistemas inteligentes en entornos centralizados y distribuidos. (To understand the methods of knowledge representation and reasoning applicable to the development of intelligent systems in centralized and distributed environaments). TIPO: Conocimientos o contenidos.

S5 - Almacenar conocimiento de forma que sea procesable por sistemas informáticos, posibilitando su reutilización en diferentes aplicaciones, y construir sistemas con capacidades de razonamiento para realizar de forma automática tareas tales como planificación o análisis de consistencia. (To store knowledge in a way that is processable by computer systems, enabling its reuse in different applications, and build systems with reasoning capabilities to automatically perform tasks such as planning or consistency analysis). 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.

* 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

This course presents **logic programming**, one of the fundamental programming paradigms (together with functional, imperative, and object-oriented programming). It is based on the use of logic as a practical language for programming applications. The course starts by presenting techniques for problem representation and problem solving using pure logic programming. The next step is programming with contemporary versions of Prolog, as well as efficient programming in this language, with special emphasis on applications in artificial intelligence. The course also presents an introduction to **constraint logic programming**, and some advanced topics. It is fundamentally a practical, programming-oriented course in which the students will complete a number of programming assignments using an advanced programming system which allows programming with pure logic programming, Prolog, functions, higher-order, constraints, and several other extensions.

4.2. Syllabus

1. Introduction
    1.1. Problem solving and automated theorem proving
    1.2. What is (C)LP?
2. Pure Logic (relational) Programming
    2.1. Syntax and semantics
    2.2. Resolution, unification, controlling search
    2.3. Data structures
    2.4. Recursive programming
    2.5. Graphs, automata
3. Prolog
    3.1. Execution model
    3.2. Arithmetic
    3.3. Data structures
    3.4. Meta-programming, higher order, aggregation predicates
    3.5. Program inspection and modification
    3.6. Cut and negation
    3.7. Incomplete data structures, grammars
    3.8. [Optional] Techniques for efficient Prolog programming
4. Introduction to Constraint Logic Programming (CLP)
    4.1. Constraint satisfaction
    4.2. Basic constraint programming techniques (Q/R and finite domains)
5. [Optional] (C)LP theory
    5.1. Review of first-order predicate logic
    5.2. Resolution
    5.3. Fundamental results
    5.4. Semantics of (constraint) logic programs

5. Schedule

5.1. Subject schedule*

Week	Type 1 activities	Type 2 activities	Distant / On-line	Assessment activities
1	**1.1 y 1.2** Duration: 02:00 Lecture			
2	**2.1 y 2.2** Duration: 02:00 Lecture			
3	**2.3** Duration: 01:00 Lecture **2.1-2.3** Duration: 01:00 Problem-solving class			
4	**2.4** Duration: 02:00 Lecture			**Practical programming exercises 1** Individual work Progressive assessment Not Presential Duration: 00:00
5	**2.5** Duration: 02:00 Lecture			
6	**2.4-2.5** Duration: 01:00 Problem-solving class **3.1-3.2** Duration: 01:00 Lecture			**Practical programming exercises 2** Individual work Progressive assessment Not Presential Duration: 00:00
7	**3.3** Duration: 02:00 Lecture			
8	**3.4** Duration: 02:00 Lecture			
9	**3.5** Duration: 01:00 Lecture **3.1-3.5** Duration: 01:00 Problem-solving class **Actividades Transversales** Duration: 02:00 Additional activities			

10	**3.6-3.7** Duration: 02:00 Lecture			
11	**3.8** Duration: 01:00 Lecture **3.6-3.8** Duration: 01:00 Problem-solving class **Actividades Transversales** Duration: 02:00 Additional activities			
12	**4.1** Duration: 02:00 Lecture			**Programming project** Individual work Progressive assessment Not Presential Duration: 00:00
13	**4.2** Duration: 01:00 Lecture **4.1-4.2** Duration: 01:00 Problem-solving class **Actividades Transversales** Duration: 02:00 Additional activities			
14	**5.1-5.2** Duration: 02:00 Lecture			
15	**5.3-5.4** Duration: 02:00 Lecture **Actividades Transversales** Duration: 02:00 Additional activities			
16				
17				**Global Test - Assignments Turn-In** Online test Progressive assessment and Global Examination 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
4	Practical programming exercises 1	Individual work	No Presential	00:00	%	5 / 10	C7 C8 S8 K5 S5 C3 C9
6	Practical programming exercises 2	Individual work	No Presential	00:00	%	5 / 10	C7 C8 S8 K5 S5 C3 C9
12	Programming project	Individual work	No Presential	00:00	%	5 / 10	C7 C8 S8 K5 S5 C3 C9
17	Global Test - Assignments Turn-In	Online test	Face-to-face	02:00	100%	5 / 10	C7 C8 S8 K5 S5 C3 C9

6.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
17	Global Test - Assignments Turn-In	Online test	Face-to-face	02:00	100%	5 / 10	C7 C8 S8 K5 S5 C3 C9

6.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
Global Test - Assignment Turn-In	Online test	Face-to-face	02:00	100%	5 / 10	C7 C8 S8 K5 S5 C3 C9

6.2. Assessment criteria

Course evaluation system:

The normal evaluation system for the course, which is applied to all students, is by progressive evaluation.

- Being an eminently practical subject, in addition to various class exercises, evaluable practical assignments will be carried out during the course.
- These assignments must be carried out individually.
- The statements, instructions, information on the systems to be used, etc., will be sent by email and Moodle.
- The final grade of the course will be the average of the assignments. There is no minimum grade for each assignment and it is possible to carry out the second assignment even if the first one has not been delivered or approved.

Evaluation by global test:

The evaluation by global test will consist in the recovery of (turning in again) the assignments that had not been turned in or had been failed. Turning in the assignments at this time and getting a sufficient grade (>= 5) will allow passing the course.

Extraordinary evaluation:

Those students who have not passed the course may take the extraordinary evaluation. This will also include the recovery of (turning in again) the assignments (with a grade >= 5) that had not been turned in or had been failed.

Sistema de evaluación de la asignatura:

El sistema normal de evaluación de la asignatura, que se aplica a todos los alumnos, es por evaluación progresiva.

- Al ser una asignatura eminentemente práctica, además de diversos ejercicios de clase, se realizarán prácticas evaluables durante el curso.
- Dichas prácticas se realizarán de forma individual.
- Los enunciados, instrucciones, información sobre los sistemas a utilizar, etc., se enviarán por correo electrónico y Moodle.
- La nota final del curso será la media de las prácticas. No hay nota mínima para cada práctica y es posible realizar cada práctica aunque no se haya entregado o aprobado otras.

Evaluación mediante prueba global:

La evaluación mediante prueba global consistirá en la recuperación de las prácticas que no se hubieran entregado o se hubieran suspendido anteriormente. La presentación de las prácticas obteniendo suficiente puntuación (>= 5) permitirá superar la asignatura.

Evaluación extraordinaria:

Aquellos estudiantes que no hayan superado la asignatura podrán presentarse a la evaluación extraordinaria. Ésta consistirá también en la recuperación de las prácticas (con calificación >= 5) que no se hubieran entregado o se hubieran suspendido anteriormente.

7. Teaching resources

7.1. Teaching resources for the subject

Name	Type	Notes
``The Art of Prolog" (Second edition), Sterling & Shapiro, MIT Press, 1994.	Bibliography	
``From Logic Programming to Prolog", K. Apt, Prentice-Hall, 1997.	Bibliography	
``Prolog Programming for Artificial Intelligence", I. Bratko, Addison-Wesley Ltd. 1990 (2nd edition); 2000 (3rd edition).	Bibliography	
``Programming in Prolog", Clocksin & Mellish, 1981, Springer-Verlag.	Bibliography	
``Programming with Constraints: An Introduction", Marriott & Stuckey, MIT Press, 1998.	Bibliography	
``Essentials of Logic Programming", C. Hogger, 1990, Clarendon Press, Oxford.	Bibliography	
Sitio Moodle de la asignatura	Web resource	
Course web site	Web resource	http://www.clip.dia.fi.upm.es/prode
Ciao Prolog Playground	Web resource	https://ciao-lang.org/playground
Ciao Prolog programming system	Web resource	http://ciao-lang.org
Emacs programming environment for Ciao	Web resource	https://ciao-lang.org/install.html
Visual Studio Code programming environment for Ciao	Web resource	https://marketplace.visualstudio.com/items?itemName=ciao-lang.ciao-prolog-vsc
Aula	Equipment	

Sala de trabajo en grupo	Equipment	
Laboratorio: Centro de Cálculo	Equipment	

8. Other information

8.1. Other information about the subject

- This course is relevant to "**Sustainable Development Goal Number 9**" (Industry, Innovation, and Infrastructure) defined by the United Nations Program for Sustainable Development (www.undp.org) as related to innovation and research in information technology.

Teaching innovation

The following "Learning By Doing" actions:

- Students are provided for programming environments developed for the subject in various IDS (EMACS, VSC, etc.) as well as a playground in the browser that does not need installation.
- Links are provided from the transparencies to online exercises and examples with self-correction on this platform (Playgorund) developed ex-professional for the signature. This makes it possible to assign and complete exercises during classes and at home.
- In addition to transparencies and texts, some help videos are provided for the installation and use of the programming systems used and for some specific topics of the subject.
- For grading exercises, self-correctors are used on the Deliverit platform, which, by providing direct feedback

to students about their homeworks, are very important didactic elements.