



POLITÉCNICA

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PR/CL/001



E.T.S. de Ingenieros
Informáticos

ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

103000366 - Multi-agent Systems

DEGREE PROGRAMME

10AJ - Master Universitario En Inteligencia Artificial

ACADEMIC YEAR & SEMESTER

2022/23 - Semester 1

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1. Description

1.1. Subject details

Name of the subject	103000366 - Multi-Agent Systems
No of credits	5 ECTS
Type	Optional
Academic year of 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 - Escuela Tecnica Superior De Ingenieros Informaticos
Academic year	2022-23

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Josefa Zuleide Hernandez Diego	2205	josefaz.hernandez@upm.es	Sin horario. http://www.dia.fi.upm.es/es/tutorias
Nikolaus Guyon Swoboda (Subject coordinator)	2205	nik.swoboda@upm.es	Sin horario. http://www.dia.fi.upm.es/es/tutorias

Javier Bajo Perez	2101	javier.bajo@upm.es	Sin horario. http://www.dia.fi.upm.es/es/tutorias
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* 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

CB10 - Que los estudiantes posean las habilidades de aprendizaje que les permitan continuar estudiando de un modo que habrá de ser en gran medida autodirigido o autónomo.

CB7 - 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 su área de estudio

CB9 - Que los estudiantes sepan comunicar sus conclusiones y los conocimientos y razones últimas que las sustentan a públicos especializados y no especializados de un modo claro y sin ambigüedades

CG10 - Capacidad de pensamiento creativo con el objetivo de desarrollar enfoques y métodos nuevos y originales.

CG11 - Integración del conocimiento a partir de disciplinas diferentes, así como el manejo de la complejidad.

CG18 - Capacidad de trabajar y comunicarse también en contextos internacionales

CG9 - Aplicación de los métodos de resolución de problemas más recientes o innovadores y que puedan implicar el uso de otras disciplinas.

CG11 - Adquirir conocimientos científicos avanzados del campo de la informática que le permitan generar nuevas ideas dentro de una línea de investigación.

CG12 - Comprender el procedimiento, valor y límites del método científico en el campo de la Informática, siendo capaz de identificar, localizar y obtener datos requeridos en un trabajo de investigación, de diseñar y guiar investigaciones analíticas, de modelado y experimentales, así como de evaluar datos de una manera crítica y extraer conclusiones.

CG13 - Capacidad para valorar la importancia de las fuentes documentales, manejarlas y buscar la información para el desarrollo de cualquier trabajo de investigación.

CG14 - Capacidad de leer y comprender publicaciones dentro de su ámbito de estudio/investigación, así como su catalogación y valor científico.

3.2. Learning outcomes

RA57 - Ser capaz de analizar y diseñar sociedades de agentes que simulen comportamientos inteligentes

RA58 - Ser capaz de analizar y evaluar la aportación de publicaciones científicas.

RA56 - Ser capaz de entender el comportamiento y auto-organización de sistemas complejos compuestos de múltiples agentes

* 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 has two main objectives:

(i) to acquire a general familiarity with multi-agent systems from the perspective of collective intelligence (CI) and then to pursue a deeper understanding of a number of specific areas of research related to CI.

(ii) to give each student some "hands-on" experience doing research and reporting the results of that research activity in the format normally required for submission to an international conference.

Note: all of the course materials will be provided in English, but lectures will be offered in a mixture of both Spanish and English to guarantee the best communicative results.

Esta asignatura tiene dos objetivos principales:

(i) adquirir una familiaridad general con los sistemas multiagente desde la perspectiva de la inteligencia colectiva al tiempo que se estudian con más profundidad algunas áreas de investigación concretas relacionadas con la

inteligencia colectiva.

(ii) proporcionar a los alumnos alguna experiencia práctica sobre cómo investigar y comunicar los resultados de la actividad investigadora, empleando un formato habitualmente requerido en conferencias internacionales.

Nota: todos los materiales del curso se proporcionarán en inglés, pero las clases se ofrecerán en una combinación de español e inglés para garantizar los mejores resultados comunicativos.

4.2. Syllabus

1. Introduction

1.1. What is collective intelligence?

1.2. Basic concepts of collective intelligence

2. Case studies - Analysis and modeling of collective intelligence

2.1. Collaborative sorting

2.2. Distributed task allocation

2.3. Collective construction

2.4. Ant foraging

2.5. Flocking

2.6. Collaborative transport

2.7. Other collective intelligence systems

3. Put it into practice

3.1. Implementation of a collective intelligence system

5. Schedule

5.1. Subject schedule*

Week	Classroom activities	Laboratory activities	Distant / On-line	Assessment activities
1	Topic 1 - Course description and overview Duration: 02:00 Lecture			
2	Topic 1 - Introduction to self-organization and emergence Duration: 01:30 Lecture Topic 1 - Introduction to self-organization and emergence Duration: 00:30 Cooperative activities			
3	Topic 2 - Collaborative sorting and distributed task sorting Duration: 02:00 Lecture			
4	Topic 2 - Collaborative sorting and distributed task sorting Duration: 01:30 Additional activities Topic 3 - Put it into practice Duration: 00:30 Cooperative activities			Peer evaluation (1) of the presentations Other assessment Continuous assessment Not Presential Duration: 01:00
5	Topic 2 - Ant foraging Duration: 02:00 Lecture			
6	Topic 2 - Ant foraging Duration: 01:30 Additional activities Topic 3 - Put it into practice Duration: 00:30 Cooperative activities			Peer evaluation (2) of the presentations Other assessment Continuous assessment Not Presential Duration: 01:00
7	Topic 2 - Flocking Duration: 02:00 Lecture			
8	Topics 2 - Flocking Duration: 01:30 Additional activities Topic 3 - Put it into practice Duration: 00:30 Cooperative activities			Peer evaluation (3) of the presentations Other assessment Continuous assessment Not Presential Duration: 01:00

9	<p>Topic 2 - Collective construction Duration: 02:00 Lecture</p>			
10	<p>Topic 2 - Collective construction Duration: 01:30 Additional activities</p> <p>Topic 3 - Put it into practice Duration: 00:30 Cooperative activities</p>			<p>Peer evaluation (4) of the presentations Other assessment Continuous assessment Not Presential Duration: 01:00</p>
11	<p>Topic 2 - Collaborative transport Duration: 02:00 Lecture</p>			
12	<p>Topic 2 - Collaborative transport Duration: 01:30 Additional activities</p> <p>Topic 3 - Put it into practice Duration: 00:30 Cooperative activities</p>			<p>Peer evaluation (5) of the presentations Other assessment Continuous assessment Not Presential Duration: 01:00</p>
13	<p>Topic 2 - Other collective intelligence systems Duration: 02:00 Lecture</p>			<p>Preliminary submission of the final report Individual work Continuous assessment and final examination Not Presential Duration: 03:00</p>
14	<p>Topic 2 - Other collective intelligence systems Duration: 01:30 Additional activities</p> <p>Topic 3 - Put it into practice Duration: 00:30 Cooperative activities</p>			<p>Peer evaluation (6) of the presentations Other assessment Continuous assessment Not Presential Duration: 01:00</p>
15	<p>Topic 2 - Other collective intelligence systems Duration: 02:00 Lecture</p>			
16	<p>Topic 2 - Other collective intelligence systems Duration: 01:30 Additional activities</p> <p>Topic 3 - Put it into practice Duration: 00:30 Cooperative activities</p>	<p>Group help sessions held throughout the semester Duration: 08:00 Additional activities</p>		<p>Peer evaluation (7) of the presentations Other assessment Continuous assessment Not Presential Duration: 01:00</p> <p>Presentation of a scientific paper Individual presentation Continuous assessment Presential Duration: 00:00</p> <p>Class participation Other assessment Continuous assessment Presential Duration: 00:00</p>

17				Implementation of a collective intelligence system and final report Individual work Continuous assessment and final examination Not Presential Duration: 40:00 Demonstration of the collective intelligence system developed Individual presentation Continuous assessment and final examination Presential Duration: 00:15
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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.

* The schedule is based on an a priori planning of the subject; it might be modified during the academic year, especially considering the COVID19 evolution.

6. Activities and assessment criteria

6.1. Assessment activities

6.1.1. Assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
4	Peer evaluation (1) of the presentations	Other assessment	No Presential	01:00	2.85%	0 / 10	
6	Peer evaluation (2) of the presentations	Other assessment	No Presential	01:00	2.85%	0 / 10	
8	Peer evaluation (3) of the presentations	Other assessment	No Presential	01:00	2.86%	0 / 10	
10	Peer evaluation (4) of the presentations	Other assessment	No Presential	01:00	2.86%	0 / 10	
12	Peer evaluation (5) of the presentations	Other assessment	No Presential	01:00	2.86%	0 / 10	
13	Preliminary submission of the final report	Individual work	No Presential	03:00	5%	0 / 10	
14	Peer evaluation (6) of the presentations	Other assessment	No Presential	01:00	2.86%	0 / 10	
16	Peer evaluation (7) of the presentations	Other assessment	No Presential	01:00	2.86%	0 / 10	
16	Presentation of a scientific paper	Individual presentation	Face-to-face	00:00	15%	0 / 10	CB9 CG10 CG11 CG18 CGI4 CGI3
16	Class participation	Other assessment	Face-to-face	00:00	5%	0 / 10	
17	Implementation of a collective intelligence system and final report	Individual work	No Presential	40:00	50%	0 / 10	CG10 CG11 CB7 CG9 CGI1 CGI2 CGI4 CB10 CGI3

17	Demonstration of the collective intelligence system developed	Individual presentation	Face-to-face	00:15	5%	0 / 10	CB7 CB9 CG18
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6.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
13	Preliminary submission of the final report	Individual work	No Presential	03:00	5%	0 / 10	
17	Implementation of a collective intelligence system and final report	Individual work	No Presential	40:00	50%	0 / 10	CG10 CG11 CB7 CG9 CG11 CG12 CG14 CB10 CG13
17	Demonstration of the collective intelligence system developed	Individual presentation	Face-to-face	00:15	5%	0 / 10	CB7 CB9 CG18

6.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
Implementation of a collective intelligence system and final report	Individual work	Face-to-face	40:00	50%	0 / 10	CB7 CG9 CG11 CG12 CG14 CB10 CG13 CG10 CG11
Demonstration of the implemented collective intelligence system	Individual presentation	Face-to-face	00:15	5%	0 / 10	CB9 CG18 CB7
Preliminary submission of the final report	Individual work	Face-to-face	03:00	5%	0 / 10	

6.2. Assessment criteria

Continuous evaluation

Each student's final grade will be calculated using the following items and weights:

- 5% - Class participation (Prior to class meetings, assigned readings for that day will be announced and all students are expected to come to class prepared to actively participate in the discussion of those articles.)
- 15% - In class presentation (During the semester, each student will be expected to make one in class presentation/discussion.)
- 20% - Peer evaluations of the presentations (In the week following a paper presentation class, each student is required to submit a brief commentary on each of the presentations made by the other students.)
- 5% - Preliminary submission of the final report (Towards the end of the semester students will be expected to submit a short report outlining their progress with the final project.)
- 50% - Project implementation and final report (At the end of the semester each student will be expected to submit the implementation of a simulation of a CI system along with a short report describing this project.)
- 5% - Demonstration of the implemented system

Global evaluation

In this case, the final grade will be obtained using the same items and weights described above. The student has to submit the implementation of a simulation of a CI system along with a short report describing this project, in the date officially assigned for this evaluation. Shortly after the submission of the report, the student must also give a short demo of the implemented system.

The following activities can not be recovered: class participation, in class presentation and the peer evaluations of the student presentations. One of the principal goals of these activities is to engage all of the students of the class in a critical discussion of the topics covered by the course. Thus, these activities can not be recovered after the end of class and if none of them were realized in class the maximum grade that a student can receive in only global evaluation is a 6.

Evaluation in the extraordinary period

Identical to global evaluation.

Evaluación continua

La calificación final en este curso se obtendrá a partir de lo siguiente:

- 5% - Participación en clase (A lo largo del semestre, especialmente tras la presentación de nuevos temas, los alumnos deben prepararse el/los artículos seleccionados por los profesores con el objetivo de extraer los contenidos más relevantes y aportar su valoración personal sobre los mismos, así como otros aspectos a comentar o discutir. Se espera que todos los alumnos estén preparados para participar en la discusión, por lo que los profesores, u otros alumnos, podrán interpelar directamente a sus compañeros.)
- 15% - Presentación (Todos los alumnos deben hacer al menos una presentación/discusión de un artículo a lo largo del semestre.)
- 20% - Evaluaciones por pares (Después las clases de presentación de artículos por parte de los alumnos, se pedirá a los alumnos presentes que elaboren una breve evaluación de las presentaciones realizadas por sus compañeros.)
- 5%: Entrega preliminar del proyecto final (Hacia el final del semestre, cada alumno debe presentar un breve informe describiendo su trabajo inicial para el proyecto final.)
- 50% - Proyecto y informe (Al final del curso, cada alumno debe entregar un proyecto que implemente un modelo de inteligencia colectiva. La entrega del proyecto irá acompañada de un informe sobre la misma.)
- 5% - Demostración (Cada alumno debe realizar una demo breve del sistema implementado.)

Evaluación global

La calificación en caso de evaluación global se obtendrá por los mismos conceptos y porcentajes detallados anteriormente. El alumno debe realizar una práctica que implemente un modelo de inteligencia colectiva, así como un breve informe sobre la misma. Esta práctica, y el informe correspondiente, deberán entregarse en la fecha prevista para dicha evaluación, en la que además se realizarán una demo breve de la práctica desarrollada por el alumno.

No será posible recuperar las siguientes actividades: participación en clase, la presentación y las evaluaciones por pares. Uno de los principales objetivos de estas actividades es involucrar a todos los alumnos en una discusión crítica de los temas tratados. Por lo tanto, estas son actividades que no se pueden recuperar una vez finalizado el periodo de las clases y si no se ha realizado ninguna de ellas durante las clases la nota máxima que un alumno puede obtener en solamente evaluación global es un 6.

Evaluación extraordinaria

Idéntica a la evaluación global.

7. Teaching resources

7.1. Teaching resources for the subject

Name	Type	Notes
Bonabeau, E., Dorigo, M. and Theraulaz, G., Swarm Intelligence: From Natural to Artificial Systems, 1999.	Bibliography	
Camazine, S. et al., Self-organization in Biological Systems, 2001.	Bibliography	
Floreano, D. and Mattiussi, C., Bio-Inspired Artificial Intelligence: Theories, Methods and Technologies, 2008.	Bibliography	
Artículos relevantes y otra documentación on-line se proporcionarán a lo largo del curso	Others	
Asignatura disponible en la plataforma institucional de teleenseñanza de la UPM	Web resource	

8. Other information

8.1. Other information about the subject

This course will use Moodle to distribute information and documentation, to announce and submit assignments, and to publish grades.

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La asignatura se apoya en la herramienta Moodle para proporcionar información y documentación a los alumnos, así como para la asignación de enunciados y entregas de las prácticas, y la comunicación de las calificaciones de los alumnos.