

**Knowledge, Reasoning and Uncertainty**

Code: 102786  
ECTS Credits: 6

Degree	Type	Year	Semester
2502441 Computer Engineering	OB	3	1
2502441 Computer Engineering	OT	4	1

**Contact**

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**Use of Languages**

Principal working language: catalan (cat)  
Some groups entirely in English: No  
Some groups entirely in Catalan: Yes  
Some groups entirely in Spanish: No

**Prerequisites**

There are no prerequisites. However, it is recommended, to take this subject, that the minimum competences have been reached in the subjects of "Fonaments d'Informàtica" and "Metodologia de la Programació" (first year), as well as "Intel·ligència Artificial" and "Laboratori de Programació" (second year).

**Objectives and Contextualisation**

The subject of Coneixement, Raonament i Inertesa, is framed within the mention of "Computing", along with the subjects of "Aprentatje Computacional", "Visió per Computador" and "Robòtica, Llenguatge i Planificació". Due to its subject matter, this subject is closely related to the subject of "Artificial Intelligence" of the second year and "Aprentatje Computacional" of the third year. Likewise, the developed knowledge serves in part of the content of the subject of "Robòtica, Llenguatge i Planificació".

The subject aims, both expand some of the topics developed during "Artificial Intelligence", and introduce new problems associated with artificial intelligence, mainly the reasoning with partial or 'not exact' knowledge.

The first part will deal with the expansion of the search mechanisms developed in the second year, introducing generic algorithms to solve constraint satisfaction problems as a reasoning mechanism (i.e. production planning, maximizing efficiency in logistics decisions, etc.). In a second part the bases for representation of knowledge associated with problems are given to be able to make decisions for their resolution. The last part will introduce the basic techniques to be able to extract information, and therefore solutions, when the information that is available or not is completely reliable or is not perfectly defined (Ex: weather forecasts, voice recognition, when a production is can consider good or not and to what extent, etc).

One of the objectives of the subject is that the student knows how to face the solution to problems in different contexts of the treaties, from identifying the needs of knowledge representation and, according to this, applying the most appropriate techniques.

**Competences**

Computer Engineering

- Acquire thinking habits.
- Communication.
- Have the capacity for in-depth knowledge of the fundamental principles and models of computation and know how to apply them to interpret, select, value, model and create new concepts, theories, uses and technological developments related with IT.
- Have the capacity to acquire, obtain, formalise and represent human knowledge in a computable form to solve problems by means of a computer system in any field of application, particularly related with aspects of computation, perception and performance in intelligent environments.
- Work in teams.

## Learning Outcomes

1. Accept and respect the role of the various team members, and its different levels of dependence.
2. Communicate efficiently, orally or in writing, knowledge, results and skills, both in the professional environment and before non-expert audiences.
3. Develop a mode of thought and critical reasoning.
4. Develop mechanisms to search for state space through the representation and classification of knowledge.
5. Implement heuristics to speed up searches for optimum solutions in case studies.
6. Know and understand techniques for the representation of human knowledge.
7. Use efficiently ICT communication and transmission of ideas and results.

## Content

The content develops the three parts of the subject ascending in complexity.

- Introduction: multiagent concept.
- Search algorithms for reasoning: Local search. Search with restrictions.
- Knowledge Representation: Decision making: Decision trees, Spaces of Versions. Association rules
- Reasoning with uncertainty: Bayesian reasoning. Bayesian networks, the case of hidden Markov networks.

## Methodology

All the information of the subject and the related documents that the students need will be found in the page Caronte (<http://caronte.uab.cat/>), the menu of the subject Knowledge, reasoning and uncertainty. The different activities that will be carried out in the subject are organized as follows:

### Lectures

The main concepts and algorithms of each theory topic will be presented. These subjects suppose the starting point in the work of the subject.

### Problem seminars

They will be classes with small groups of students, which facilitate the interaction, or of individual character, according to the cases. In these classes, practical cases will be considered that require the design of a solution in which the methods seen in the theory classes are used. It is impossible to follow the kinds of problems if the contents of the theory classes are not followed. The result of these sessions is the resolution of the problems that must be delivered on a weekly basis. The specific mechanism for the delivery will be indicated on the web page of the subject (Charon space).

## Laboratory practicum

The working groups will be formed by groups of 3-4 students and should form the second week of the course. These working groups must be maintained until the end of the course and they must self-manage: role distribution, work planning, assignment of tasks, management of available resources, conflicts, etc. Although the teacher will guide the learning process, his intervention in the management of the groups will be minimal.

At the beginning of the course, the problems to be solved will be presented and the students will define their own project. Throughout the semester, students will work in cooperative groups and should analyze the chosen problem, design and implement solutions based on different computational learning algorithms seen in class, analyze the results obtained in each of the methods and defend their project in public.

To develop the project, the groups will work autonomously and the practice sessions will be devoted mainly to answer questions with the teacher who will monitor the status of the project, indicate errors to be corrected, propose improvements, etc.

Some of the sessions will be marked as control sessions in which some part of the project must be delivered. In these sessions the groups must explain the work done and the teacher will ask questions to all group members to assess the work done. Attendance at these sessions is mandatory.

In the last session of each of the internship projects, the groups will make a presentation of the project where they will explain the project developed, the solution adopted and the results obtained. In this presentation each member of the group must make a part of the presentation.

Transversal competences:

- T01.01 - Develop a critical mode of thinking and reasoning. Students must reason freely to decide between the different alternatives they will have when solving problems and practices, mainly. In the latter case they are free to choose language, structure and strategies to solve the challenges. The code note explicitly evaluates how good the resolution obtained is and, therefore, the capacity for critical thinking and reasoning.
- T03.02 - Assume and respect the role of the various team members, as well as the different levels of dependence of the team. There is a self-evaluation form in the practices in which the students evaluate each other regarding the work they have done for the group and their relationship during the development of the projects. There is a percentage of the final grade that reflects this evidence. The details are in the evaluation section.
- T04.01 - Communicate efficiently, orally or in writing, knowledge, results and skills, both in professional environments and non-expert public and T04.02 - Make efficient use of ICT in communication and the transmission of ideas and results. In the evaluation of the practices there are three specific points related to these competences: individual evaluation of the presentation, group evaluation of the presentation and evaluation of the memory. The three evidences have a percentage reflected in the final formula within the evaluation section. The T04.02 competition evaluates in the two previous end points. Therefore, both the ability to use ICT and the written discursive capacity of the entire work team are taken into account. The first point evaluates the competition T04.01 although it is mixed with the other two points. The objective is to assess the verbal and non-verbal communication capacity of each of the students individually.

## Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Lectures	22	0.88	6, 4, 3, 5
Type: Supervised			
Lab practicums	12	0.48	6, 4, 3, 5

Problem seminars	12	0.48	2, 4, 3, 7, 5
Type: Autonomous			
Individual study	40	1.6	6, 4, 3, 5
Setup and development of practical projects	42	1.68	1, 2, 6, 4, 3, 7, 5

## Assessment

Activities and evaluation instruments:

To assess the achievement of the knowledge and skills associated with the subject, an evaluation mechanism is established that combines the assimilation of knowledge, the ability to solve problems, and significantly, the ability to generate computational solutions to complex problems, both group as individually.

With this objective, the evaluation is divided into three parts:

- Evaluation of theoretical knowledge

The final theory grade will be calculated from two partial exams:

Theory Grade =  $(0.5 * \text{Partial 1}) + (0.5 * \text{Partial 2})$

To be able to have a theory note it will be necessary that the notes of each one of the partials be superior to 4.

Partial 1 is done in the middle of the semester and serves to eliminate part of the subject if it is approved.

Partial 2 is done at the end of the semester and serves to eliminate part of the subject if it is approved.

These exams aim at an individualized evaluation of the student with their abilities to solve problems using the techniques explained in class as well as to evaluate the level of conceptualization that the student has made of the techniques seen.

Recovery exam. In case the theory note does not reach the appropriate level in any of the partial, to obtain a final grade sufficient to consider the achievement of knowledge, students can submit to the examination of the call for the subject and redo an exam that evaluates the contents seen in the subject of the failed ones. Only in the evaluation of the theoretical contents there is the possibility of recovery. In case of showing up to raise the grade, the high grade prevails.

There are no validations in case the theoretical part had been overcome in previous years.

- Evaluation of practicum projects

The evaluation of each of the projects will include:

- Joint evaluation of the project: single note for all members of the working group that will assess the overall result of the project, the quality of the code, the general structure of the final presentation and the documents delivered throughout the project.
- Individual assessment for each group member: individual work will be assessed based on the answers to the questions in the control sessions and the final presentation of the project.
- Peer evaluation: short confidential form qualifying the contribution of each group partner to the final result.

The project mark will be calculated according to the formula:

Project Grade =  $(0.6 * \text{Group Note}) + (0.3 * \text{Individual Note}) + (0.1 * \text{Av. Between equals})$

Group Grade =  $(0.6 * \text{Program}) + (0.2 * \text{Presentation}) + (0.2 * \text{Documentation})$

$$\text{Individual Grade} = (0.5 * \text{Individual work}) + (0.5 * \text{Presentation})$$

The final note of practices will be the average of the marks of the projects, having to obtain a minimum of 3.5 in each of them. If this minimum is not reached in any of the projects, the final note of practices will have a maximum of 3.5.

In case of not passing any of the practicum projects will allow the recovery of the code and the memory of the unsuccessful projects, but not the oral presentation.

In case of repeating students with the practical part exceeded (minimum 6) the previous year exclusively, they may validate those parts of the practices that are the same as the previous year. The student must communicate this circumstance to the teaching team at the beginning of the course. It is also the responsibility of the student to communicate to his fellow students if they are object of validation or not. Otherwise, the faculty can exclude the student from the group of practices, becoming an individual group and penalize it if the classmates have suffered any damage. That is why it is recommended that the students susceptible to receive validations be grouped together in the groups of practices.

#### - Evaluation of work in problem seminars

The objective of the problems is to cause the student to enter the content of the subject continuously and from small problems that make him or her directly familiar with the application of the theory. As evidence of this work, the presentation of a portfolio is requested in which he will have kept the problems that he will have been doing. This portfolio will have digital weekly delivery. There will not be an individualized weekly follow-up, but the student will be able to self-evaluate continuously since he will have the solutions of each one of the sets of problems once the delivery period has ended. Together with the tutoring hours in case doubts appear, it is enough for each student to identify their weak points.

$$\text{Problems Grade} = \text{Portfolio evaluation}$$

The final grade of the subject is obtained by combining the evaluation of these 3 activities as follows:

$$\text{Final Grade} = (0.4 * \text{Theory}) + (0.5 * \text{Project}) + (0.1 * \text{Problems})$$

Conditions to pass the subject:

- The final grade of theory must be greater than or equal to 4 in order to pass the subject.
- The grade of the project must be greater than or equal to 6 in order to pass the subject.

If the mark, applying the formula of the previous section ("final grade of the subject"), was greater than 5 but the minimum required in any of the parts had not been exceeded, the final grade in the file will be 4,5.

As many honorary registrations (Md'H) will be assigned as the current regulations allow as long as the grade is higher than 9.0. The assignment of the registration will be done following the order of notes. In case there are multiple candidates with the same evaluation capable of receiving Md'H, supplementary activities will be proposed to determine the best curricula.

The student will be classified as "Not Evaluable" if he / she does not have any part evaluated neither of the theoretical contents nor of the practical contents.

Important notices:

- The dates of continuous evaluation and delivery of works, as well as all the teaching material will be published in the Caronte site (<http://caronte.uab.cat/>), in the space of this subject and can suffer programming changes because of adaptation to possible incidents. caronte.uab.cat will always be informed about these changes since it is understood that Charon will convert the usual mechanism of exchange of information between teacher and students.

- For each evaluation activity, a place, date and time of revision in which the student can review the activity with the teacher will be indicated. In this context, claims may be made on the activity grade, which will be evaluated by the faculty responsible for the subject. If the student does not appear in this revision, it will not be revised later to this activity.
- Notwithstanding other disciplinary measures deemed appropriate, and in accordance with the academic regulations in force, assessment activities will receive a zero whenever a student commits academic irregularities that may alter such assessment. Assessment activities graded in this way and by this procedure will not be re-assessable. If passing the assessment activity or activities in question is required to pass the subject, the awarding of a zero for disciplinary measures will also entail a direct fail for the subject, with no opportunity to re-assess this in the same academic year. Irregularities contemplated in this procedure include, among others:
  - the total or partial copying of a practical exercise, report, or any other evaluation activity;
  - allowing others to copy;
  - presenting group work that has not been done entirely by the members of the group;
  - presenting any materials prepared by a third party as one's own work, even if these materials are translations or adaptations, including work that is not original or exclusively that of the student;
  - having communication devices (such as mobile phones, smart watches, etc.) accessible during theoretical-practical assessment tests (individual exams).

The numerical note of the subject will be the lower value between 3.0 and the weighted average of the marks in case the student has committed irregularities in an evaluation act (and therefore the approved by compensation will not be possible). In summary: copy, leave copy or plagiarize (or attempt to) in any of the evaluation activities is equivalent to a FAIL with a grade lower than 3.5.

The grade of the project must be greater than or equal to 6 in order to pass the subject.

If the mark, applying the formula of the previous section ("final grade of the subject"), was greater than 5 but the minimum required in any of the parts had not been exceeded, the final grade in the file will be 4 ,5.

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## Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Individual exams	40%	7	0.28	6, 4, 3
Practicum defense (report + code + presentation + follow-up)	50%	10	0.4	1, 2, 6, 4, 3, 7, 5
Problem portfolio	10%	5	0.2	6, 3

## Bibliography

### Web links

- Subject web page -Caronte-: <http://caronte.uab.cat>
- Artificial Intelligence: A Modern Approach. <http://aima.cs.berkeley.edu/>

### Basic Bibliography

- S. Russell, P. Norvig. Artificial Intelligence: A Modern Approach. Ed. Prentice Hall, Second Edition, 2003. (Existeix traducció al castellà: Inteligencia artificial: Un Enfoque Moderno)
- T. Mitchell. Machine Learning. McGraw Hill. 1997.

### Additional Bibliography

- C. Bishop. Pattern Recognition and Machine Learning. Springer-Verlag New York, Inc. 2006