UAB
Universitat Autònoma de Barcelona

Knowledge, Reasoning and Uncertainty

Code: 102786
ECTS Credits: 6

2025/2026

Degree	Type	Year
Computer Engineering	OB	3
Computer Engineering	OT	4

Contact

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Teachers

Luis Gomez Bigorda

Teaching groups languages

You can view this information at the end of this document.

Prerequisites

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

Objectives and Contextualisation

The subject of Coneixment, Raonament i Inertesa, is framed within the mention of "Computing", along with the subjects of " Aprenentatje Computacional ", " Visió per Computador " and " Robòtica, Llenguatje i Planificació ". Due to its subject matter, this subject is closely related to the subject of "Artificial Intelligence" of the second year and " Aprenentatje Computacional " of the third year. Likewise, the developed knowledge serves in part of the content of the subject of " Robòtica, Llenguatje 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 'non 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). In these last two sections we focus on algorithms and representations that are driven by data, from which the modeling of the world they represent is extracted.

One of the objectives of the subject is that the student knows how to face the solution to problems in different contexts of thetreaties, 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 course content is structured in three main parts, increasing in complexity throughout the semester.

1) REASONING BASED ON SEARCH ALGORITHMS:

- Constraint Satisfaction Problems (CSP)
- Local search algorithms
- Simulation-based search: introduction to Monte Carlo Tree Search (MCTS)

2) KNOWLEDGE REPRESENTATION AND DECISION-MAKING:

- Model evaluation: cross-validation, bootstrap, overfitting, bias/variance
- Decision trees

- Ensembles: Random Forests and other model aggregation techniques

3) REASONING UNDER UNCERTAINTY:

- Bayesian reasoning
- Naive Bayes classifier
- Bayesian networks and Hidden Markov Models (HMMs)
- Uncertainty in modern learning systems: Deep Ensembles and Monte Carlo Dropout

Activities and Methodology

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	30	1.2	6, 4, 3, 5
Setup an ddevelopment of practical projects	52	2.08	1, 2, 6, 4, 3, 7, 5

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, and the evaluation process, 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.

One of the project in this lab sessions will be individual.

At the beginning of every 2 sessions of lab, 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 eachof themethods and defend their project inpublic.

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 the last practicum project, 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.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Assessment

Continous Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Individual evaluation test	40%	7	0.28	6, 4, 3
Practicum defense (report + code + presentation + follow-up)	55%	10	0.4	1, 2, 6, 4, 3, 7, 5
Problem portfolio	5%	5	0.2	6, 3

Evaluation activities and instruments:

To evaluate the achievement of 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-practical contents

The final grade of contents will be calculated from several evaluation test:

Note Contents = 1 / N * test_i

The number of tests may vary and they will be at least 2. In order to have a content grade, it will be necessary for the grades of each of the tests to be greater than 4.

The partial tests will be carried out during the course and may be of a practical nature (algorithm proposal for the resolution of a statement), or be of conceptual content where to answer different questions about the content developed in the 'theoretical' sessions.

These tests are intended to be an individualized evaluation of the student with their abilities to solve problems using the techniques explained in class as well as evaluating the level of conceptualization that the student has made of the techniques seen.

Recovery tests: In case the content grade does not reach the appropriate level in any of the tests, to obtain a final grade sufficient to consider the achievement of knowledge, students can take the recovery tests of the call the subject to evaluate the contents seen in the subject of the part / s not passed. In case of appearing to raise note, the highest note prevails.

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

- Evaluation of the practical projects

The evaluation of each of the projects will include:

- Joint evaluation of the project: a 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 to each member of the group: the individual work will be valued based on the answers to the questions in the control sessions and the final presentation of the project.
- Peer evaluation: brief confidential form rating each groupmate's contribution to the final result.

The project mark will have into account the quality of the computational solution (code), experimentation, documentation and defense

The final mark of practices will be the average of the marks of the projects, having to obtain a minimum of 3.5 in each one of them. In the event that this minimum is not reached in any of the projects, the final internship mark will have a maximum of 3.5.

Failure to pass any of the practical projects will allow the recovery of the code and memory of the failed projects, but not the oral presentation in case the project not passed has one.

In case of repeating students with the practical part passed (minimum 6) the previous year exclusively, they will be able to present the practices of the previous year again, adding functionality or modifying the data according to the practical teacher if the content of the project is the same or similar the year before. These students in no case may group with first year students.

There may be group projects and individual projects. Obviously, in the second case, all group notes will become individual

- Evaluation of the work in the problem seminars

The problems are intended to cause the student to enter the contents of the subject continuously and from small problems that make them become directly familiar with the application of the theory. As evidence of this work, the presentation of a portfolio in which she will have kept the problems she has been carrying out is requested. This portfolio will have weekly digital delivery. The student will be able to self-evaluate continuously since they will have the solutions of each one of the problem sets once the delivery period has ended. Along with the hours of tutoring in case doubts appear, it is enough for each student to identify their weak points.

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

Final Note = (0.35 * Contents) + (0.55 * Project) + (0.1 * Portfolio)

Conditions to pass the subject:

- The final grade for individual evaluation tests be greater than or equal to 4 to pass the course.
- The grade for the project must be greater than or equal to 6 to pass the course.

In the event that the grade, applying the formula of the previous section ("final grade of the subject"), is higher than 5 but the minimum required in any of the parts has not been exceeded, the final grade in the record will be a 4.5.

As many honors registrations will be assigned as the current regulations allow as long as the grade is higher than 9.0. The assignment of the registrations will be done following the order of notes. In case there are multiple candidates with the same evaluation likely to receive Md'H, additional activities will be proposed to determine the best candidate (s).

The student will be graded as "Not Evaluable" if he / she has no evaluated part of either the theoretical or 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 Campus Virtual (http://cv.uab.cat/), in the space of this subject and can suffer programming changes because of adaptation to possible incidents. cv.uab.cat will always be informed about these changes since it is understood that Campus Virtual will be the usual mechanism of exchange of information between teacher and students.
- This subject does not contemplate the single evaluation system.
- 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 appearinthis 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 mayalter 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 measureswill 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 practicalexercise, 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 bycompensation 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.

Use of AI

In this course, the use of Artificial Intelligence (AI) technologies is permitted as an integral part of the work development process, provided that the final outcome clearly reflects a significant contribution from the student

in terms of analysis and personal reflection. Students must clearly indicate which parts have been generated using AI tools, specify which tools were used, and include a critical reflection on how these tools influenced both the process and the final result of the activity. Lack of transparency in the use of AI will be considered a breach of academic integrity and may result in a grade penalty or more serious disciplinary actions in severe cases.

Bibliography

Web links

- Subject web page - UAB Virtual Campus: http://cv.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
- The digital references used are provided in the material of each topic.

Software

The practices must be solved in the Python programming language. If support code is provided it will be in this same language.

Groups and Languages

Please note that this information is provisional until 30 November 2025. You can check it through this link. To consult the language you will need to enter the CODE of the subject.

Name	Group	Language	Semester	Turn
(PAUL) Classroom practices	441	Catalan	first semester	morning-mixed
(PAUL) Classroom practices	442	Catalan	first semester	morning-mixed
(PLAB) Practical laboratories	441	Catalan/Spanish	first semester	morning-mixed
(PLAB) Practical laboratories	442	Catalan/Spanish	first semester	morning-mixed
(PLAB) Practical laboratories	443	Catalan/Spanish	first semester	morning-mixed
(PLAB) Practical laboratories	444	Catalan/Spanish	first semester	morning-mixed
(TE) Theory	440	Catalan	first semester	morning-mixed