Subject: Artificial Intelligence
Code: 17840
Institution: Escuela Politécnica Superior
Degree: Computer Science
Level: Graduate
Type: Core course
ECTS: 6

1. COURSE TITLE

Artificial Intelligence

1.1. Course number

17840

1.2. Course area

Computer Science

1.3. Course type

Compulsory

1.4. Course level

Graduate

1.5. Year

3rd

1.6. Semester

2nd

1.7. Credit allotment

6 ECTS

1.8. Prerequisites

In this section information is provided on the prerequisites for "Artificial Intelligence" and the courses that provide the corresponding contents

- Programming skills in a high-level language
  Courses: "Programming I", "Programming II", "Programming project"
- Linear Algebra
  Course: "Algebra"
- Calculus
  Courses: "Calculus I", "Calculus II"

- Combinatorics, graph theory and propositional logic
  Course: “Discrete structures and logic”
- Probability and statistics
  Course: “Probability and statistics”

To ensure an effective acquisition of skills and assimilation of the materials presented in this course the student is expected to

- Read of the texts included in the bibliography with a critical attitude
- Use the electronic material available in Moodle
- Use complementary material in the Web.

A good command of English is desirable because most of the recommended texts in the bibliography are in this language.

The following learning activities should be carried out with regularity

- Individual study and preparation before lectures and lab sessions: Reading of the material to be presented with the goal of acquiring familiarity with the concepts that will be used and the problems that will be addressed in those sessions.
- Individual work after these sessions:
  - Review of the notes taken down by the student in the course.
  - Complementary reading from the bibliography
  - Solve homework assignments
- Group work
  - Lab assignments
  - Participation in debate groups.

1.9. Minimum attendance requirement

1.10. Faculty data

Add @uam.es to all email addresses below.

Lectures:

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1.11. Course objectives

AI is an introductory course in Artificial Intelligence. The goal is to acquire knowledge on intelligent systems and agents, formalization of knowledge, reasoning with and without uncertainty, machine learning and applications at a basic level.

The basic **skill** that the student is expected to acquire after the successful completion of

C15. Knowledge and application of basic principles and techniques of intelligent systems and their practical applications.

Upon successful completion of the course (general goals) and after each unit (unit goals) the student will be capable of:

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GENERAL GOALS	
G1	Formalization and design of sytems capable of automated reasoning.
G2	Implementation and application of machine learning techniques in prediction problems.
G3	Implementation and application of data mining techniques

SPECIFIC UNIT GOALS	
UNIT 1.- Introduction to Artificial Intelligence	
1.1.	Understanding of the historical evolution of Artificial Intelligence
1.2.	Identification of the characteristics of an itelligent system/agent
UNIT 2.- Predicate logic	
2.1.	Formalization of knowledge using the framework of predicate logic
2.2.	Automatic reasoning in predicate logic using inference rules
2.3.	Implementation of these reasoning systems using either backward or forward inference mechanisms
2.4.	General problema solving using logic programming (Prolog)
UNIT 3.- Problem solving using search	
3.1.	Identify the type of search strategy (blind/heuristic/adversarial) that is more appropriate to address a particular problem and implement the selected strategy
3.2	Design appropriate heuristics for a particular problem
3.3	Formalize and implement constraints in search problems
UNIT 4.- Planning	
4.1	Situation calculus
4.2	Planning using STRIPS
UNIT 5.- Uncertainty in Artificial Intelligence	
5.1.	Identify the type of learning process (supervised, unsupervised, reinforcement learning) is more appropriate to address a given problem
5.2.	Extract conclusions from uncertain knowledge and quantify the uncertainty in the conclusions obtained.
UNIT 6.- Machine learning	
6.1.	Formalize knowledge using probability
6.2.	Within each of the learning paradigms, identify and implement appropriate learning strategies.
UNIT 7.- Advanced applications	
7.1.	Formalize and design solutions to practical problems of current interest using the strategies introduced during the course

1.12. Course contents

Syllabus

UNIT 1. **Introduction to Artificial Intelligence**
UNIT 2. **Problem solving using search**
UNIT 3. **Predicate logic**
UNIT 4. **Planning**
UNIT 5. **Uncertainty in AI**
UNIT 6. **Machine learning**
UNIT 7. **Advanced applications**

Detailed Syllabus

1. **Introduction to Artificial Intelligence**
   - 1.1. History of AI
   - 1.2. Systems and intelligent agents

2. **Problem solving using search**
   - 2.1 Blind search
   - 2.2 Heuristic search
     - 2.2.1 A*
     - 2.2.2 IDA*
     - 2.2.3 Optimization
     - 2.2.4 Design of heuristics
   - 2.3 Adverarial search (games)
   - 2.4 Constraint satisfaction problems

3. **Predicate logic**

   - 3.1 Elements
     - 3.1.1. Common elements with propositional logic
     - 3.1.2. Variables and quantifiers
     - 3.1.3. Predicates
     - 3.1.4. Functions
     - 3.1.5. Átoms, Térms, Literals and clauses
     - 3.1.6. Normal forms

   - 3.2 Substitution and unification

   - 3.3 Inference in predicate logic

     - 3.3.1 Generalized inference rules
       - 3.3.1.1 Modus ponens

3.3.1.2 Resolution
3.3.2 Answer extraction using Green's trick

3.4 The equality predicate

3.5 Algorithms for inference
3.5.1 Forward chaining
3.5.2 Backward chaining

3.6 Logic programming (Prolog)

3.7 Ontologies

4. Planning
4.1.1. Situation Calculus
4.1.2. Planning using STRIPS

5. Uncertainty in AI

5.1. Formalization of uncertainty using probabilities
5.1.1. Cdfs y Pdfs
5.1.2. Joint distribution
5.1.3. Marginal probabilities
5.1.4. Conditional probabilities
5.1.5. Statistical independence
5.2. Bayes' theorem
5.3. Bayes networks

6. Machine learning
6.1. Supervised learning: regression
6.1.1. Attributes and target variable
6.1.2. Linear regression by Maximum Likelihood.
6.1.3. Non-linear regresión. Neural networks.

6.2. Supervised learning: classification
6.2.1. Neural networks for classification
6.2.2. Nearest neighbors (kNNs)
6.2.3. Decision trees

6.3. Unsupervised learning
6.3.1. Introduction to clustering
6.3.2. K-means

7. Advanced applications
7.1. Natural language processing
7.2. Artificial vision
7.3. Robotics

1.13. Course bibliography

Bibliography available at the library's catalogue (click here)

Bibliography:

AI and applications [Units 1,2,3,6,7]

- Russell, S. y Norvig, P.: "Artificial Intelligence, a modern approach", Ed. Prentice Hall, 1995 (inglés y español) [http://aima.cs.berkeley.edu/]
- Nilsson, N.J.: "Artificial Intelligence, a new synthesis", Ed. Morgan Kaufmann Publishers, 1998

Uncertainty in AI and machine learning [Units 4,5]

- C.M. Bishop. Pattern Recognition and Machine Learning. Springer, 2006
- R.O. Duda, P.E. Hart. D.G. Stork; Pattern Classification; Wiley, 2000
- S. Haykin. Neural Networks: A Comprehensive Foundation. Segunda edición. Prentice-Hall 1999
- T.M. Mitchell. Machine Learning. McGraw-Hill, 1997

Applications and robotics [Unit 7]

- "Springer Handbook of Robotics", Bruno Siciliano and Oussama Khatib [http://www.springerlink.com/content/978-3-540-23957-4]

LISP programming [lab work]

- "ANSI Common Lisp", P. Graham [http://www.paulgraham.com/acl.html]
- "On LISP", P. Graham [http://lib.store.yahoo.net/lib/paulgraham/onlisp.pdf]
- Norvig, Peter; "Paradigms of artificial intelligence programming case studies in common LISP" Morgan Kaufman Publishers (1991)
- Steele, G.L.: "Common LISP the Language", segunda edición, 1990 [http://www.cs.cmu.edu/Groups/AI/html/cltl/cltl2.html]
- Lisp.org [http://www.lisp.org/alu/home]
- LISP FAQ [http://www.cs.cmu.edu/Groups/AI/html/faqs/lang/lisp/part1/faq.html]
- LISP: Style [http://www.cs.cmu.edu/Groups/AI/html/faqs/lang/lisp/part1/faq-doc-4.html]
- LISP: Specifications [http://www.lispworks.com/documentation/HyperSpec/Front/index.htm]

Journal articles

- A.M. Turing, "Computing machinery and intelligence" Mind, Vol. 59, No. 236, pp. 433-460 (1950) [http://www.jstor.org/pss/2251299]

- A. L. Samuel, "Some Studies in Machine Learning Using the Game of Checkers"
  IBM Journal of Research and Development, 3(3), pp. 210–226 (1959)
  Digital Object Identifier: 10.1147/rd.441.0206
- A. L. Samuel, "Some Studies in Machine Learning Using the Game of Checkers. II—Recent Progress"
  IBM Journal of Research and Development, 11(6), pp. 601-617 (1967)
  Digital Object Identifier: 10.1147/rd.116.0601

Additional resources:

- Asociación española para la inteligencia artificial (AEPIA)
  [http://www.aepia.org/]
- American Association for the Advancement of Artificial Intelligence (AAAI)
  [http://www.aaai.org/home.html]
- Carnegie Mellon AI repository
  [http://www-2.cs.cmu.edu/afs/cs.cmu.edu/project/ai-repository/ai/0.html]
- MIT Computer Science and Artificial Intelligence Lab (CSAIL)
  [http://www.csail.mit.edu/]
- Stanford AI Lab [http://robotics.stanford.edu/]

Online material: published in Moodle (http://uam-virtual.es)