



## Module Specification

**Module name:** Artificial Intelligence

**Code:** ICT17M2

**Programme** (Energy/ICT): ICT

**ECTS:** 6

**Type Bachelor/Msc :** MSc

**Module name:** Artificial Intelligence

**Scope and form:** face to face

**Duration** (weeks; Hours/week): 15 weeks, 4h/week (180 hours of workload)

**Type of assessment:** During the semester students must solve a project for which they can obtain a maximum of 30 points, and a test to obtain a maximum of 10 points. From the project, as well as from the test they must obtain at least half. The project is presented orally in a group. To grant the credits it is necessary to get at least 21 points. The maximum number of points students can obtain during the semester is 40 points. The final exam consists of three modules: an example, a test and a theoretical module. For each module, students can obtain maximally 20 points, 60 points in total. Students must obtain at least 10 points in each module. The resulting assessment is then calculated based on the ECTS credit system.

**Qualified Prerequisites:** no

**General module objectives:** The objective of the module are as follows: to introduce the basics of artificial intelligence, the concept of intelligent agents, to analyze problem solving and search techniques, to understand how to represent knowledge, to do planning, to reason with uncertain knowledge, to analyze techniques for decision making, and finally to introduce neural networks.

**Topics and short description:**

- **Overview:** foundations, scope, problems, and approaches of AI.
- **Intelligent agents:** reactive, deliberative, goal-driven, utility-driven, and learning agents
- **Problem-solving through Search:** forward and backward chaining, state-space search, blind search, heuristic search, problem-reduction; A, A\*, AO\* algorithms, game playing, minimax search, constraint propagation, neural networks, stochastic processes, and evolutionary search algorithms, sample applications.
- **Knowledge Representation and Reasoning:** ontologies, foundations of knowledge representation and reasoning, representing and reasoning about objects, relations, events, actions, time, and space; predicate logic, situation calculus, description logics, reasoning with defaults, reasoning about knowledge, sample applications.
- **Planning:** planning as search, partial order planning, construction and use of planning graphs



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- **Representing and Reasoning with Uncertain Knowledge:** probability, connection to logic, independence, Bayes rule, Bayesian networks, probabilistic inference, sample applications.
- **Decision-Making:** basics of utility theory, decision theory, sequential decision problems, elementary game theory, sample applications.
- **Machine Learning and Knowledge Acquisition:** learning theory, supervised learning, unsupervised learning, reinforcement learning.
- **Neural networks:** pattern recognition, multilayer neural networks, self-organizing neural networks, sample applications.

**Learning outcomes:**

Knowledge	Skills	Competences
Fundamentals for problem representation and reasoning	Able to represent problems and to formally reason about them	Students must understand how to represent problems and to reason about them
Understanding how to use efficient search techniques	Able to do practical application of search techniques	Students must be able to use efficient methods for searching
Fundamentals for using modern planning techniques	Being able to use planning techniques	Students must be able to apply planning techniques for problem solving
How to design, to develop and to manage systems with uncertain knowledge representation	Be able to manage systems with uncertain knowledge representation	Students must have the capability to manage uncertain knowledge representation techniques
Understanding the basics of decision-making techniques	Capability to understand and to use decision making techniques	Students must be able to understand decision-making techniques for problem solving
Fundamentals different machine learning techniques for knowledge acquisition	Capability to analyze and evaluate the best options for using every machine learning technique depending on the context.	Students must understand the basics of Machine Learning and be able to design and implement systems to take advantage of it.
Understand the differences and the application of the different neural network models	Capability to understand and to select the right neural network for practical applications	Students must discriminate among the different neural network models for different applications



## **Module recommended literature:**

### Main reference:

- Russell and Norvig. Artificial Intelligence: A Modern Approach. 3rd Edition. A comprehensive reference for all the AI topics of the module.

### Complementary references:

- Woolridge, M. Introduction to MultiAgent Systems. New York: Wiley (2002).
- Introduction to Machine Learning (3rd edition). Ethem Alpaydin, MIT Press (2014) ISBN-13: 978-0262028189.
- Tom Mitchell, Machine Learning. Available at: <http://www.cs.cmu.edu/~tom/mlbook.html>
- Bishop, C. M. Neural Networks for Pattern Recognition. New York: Oxford University Press (1995).
- Cowell, R. G. Lauritzen, S. L., and Spiegelhalter, D. J. Probabilistic Networks and Expert Systems Berlin: Springer (2005).
- MacKay, David. Information Theory, Inference, and Learning Algorithms. Cambridge, UK: Cambridge University Press, 2003. ISBN: 9780521642989. Available at: <http://www.inference.phy.cam.ac.uk/mackay/itila/book.html>
- Bather, J. Decision Theory: An Introduction to Dynamic Programming and Sequential Decisions. New York: Wiley (2000).
- Ghallab, M., Nau, D., & Traverso, P. Automated Planning : Theory & Practice. Palo Alto: Morgan Kaufmann (2005). Available free online.
- Hastie, Tibshirani, and Friedman. The elements of statistical learning. Available free online.
- Sutton and Barto. Reinforcement Learning: An Introduction.
- Tsang. Foundations of constraint satisfaction. Available free online.

## **Remarks:**

**Special Considerations:** Generically none for this module but should be commented on by the institution delivering the module.