UNICUSANO
ROME

Code: ING.INF/05 **Credits: 9**
Matter: Artificial Intelligence and machine learning
Main language of instruction: Italian
Other language of instruction: English

Teaching Staff

Head instructor
Prof. Andrea Dimitri – andrea.dimitri@unicusano.it

Introduction

1. *Objective of the course :*

The Artificial Intelligence and Machine Learning Course aims to provide the student with a good knowledge of the principles that govern automatic reasoning and machine learning. The course proposes the basic concepts on intelligent agents, clustering algorithms, analysis of relational networks and neural networks. Furthermore, the educational objective of the Course is to provide the student with the IT tools to consciously solve machine learning problems and analyze real cases of use of Artificial Intelligence in the world of the Internet of Things. The Etivities associated with the Course develop the skills necessary to design and validate models for inference through the use of modern, powerful and widely used tools at a professional level.

Objectives

2. *Course Structure:*
   - Introduce the basic concepts in the field of artificial intelligence
   - Present the main problem solving techniques
   - Present the main linear programming techniques
   - Present the main machine learning techniques

Competencies:

A. Knowledge and understanding.

At the end of the course, the student will have knowledge of the theories underlying artificial intelligence, as well as software techniques to creatively address and solve

problems related to the design of intelligent systems. The student will acquire the ability to use the main methodologies for the design and performance analysis of an artificial intelligence system. The student will be made able to analyze case studies and will know the main research areas of the sector. In addition, through the Etivity, students will acquire the ability to design solutions for inference and directly use and develop learning algorithms through the use of the python language.

B. Applying knowledge and understanding.
The student will be able to use the methodologies for applying the notions learned to the design and implementation of systems and architectures for intelligent systems; he will also be able to design artificial intelligence systems in a personalized way, identify problems, formulate algorithms, define implementations and evaluate the performance and characteristics of the proposed solutions.
The Etivities will drive the student in the the application of theoretical knowledge to concrete case studies.

C. Making judgements.
At the end of the he student will be able to apply the models and techniques learned to different case studies; he will also be able to interpret the performance indicators of a model, and finally to collect the data necessary for the validation of an automatic learning system.

D. Communication skills.
The student will be able to describe and hold conversations on topics related to the design, implementation and evaluation of intelligent systems, using appropriate terminology.

E. Learning skills.
The course will provide knowledge and methodological tools which might be exploited in subsequent education and professional paths, in the areas of artificial intelligence, data mining and machine learning.

Syllabus

3. *Programme of the course:*

Subject 1.
Artificial intelligence (AI) and machine learning (ML): objectives, applications, challenges. The following topics are addressed: AI or teaching a machine to perform human tasks - Intelligent Agents: rational agents and interaction with environments. Learning approaches and machine learning algorithms. Real examples of AI and

machine learning application contexts. The role of data and big data. AI and the Internet of things.

Subject 2.
AI tools where the following topics are addressed: mathematical, probabilistic, IT tools for AI and ML. Methods and algorithms for the search for local and general optimization in discrete spaces - analysis of variance and study of entropy - probability, causality, probabilistic independence - recalls of graph theory. Introduction to python programming language. Python libraries on AI and ML. What are big data, cloud computing, problems on the collection, query, management of large masses of data.

Subject 3.
Genetic programming where the following topics are addressed: genetic programming; the search for solutions - the space of states, research with graphs, uninformed research. genetic programming tutorials and languages - evaluation system and criteria.

Subject 4.
Representation and reasoning where the following topics are addressed: knowledge representation and reasoning: the propositional calculus, the resolution in the propositional calculus, the predicate calculus, the resolution in the predicate calculus, knowledge-based systems, representation of common knowledge, semantic networks and frames. Practice with Prolog.

Subject 5.
Induction and uncertainty. Bayesian networks and HMM where the following topics are addressed: inductive learning of rules; uncertainty treatment - reasoning with uncertain information, probabilistic inference with Bayesian networks. Hints on HMM (hidden Markov model).

Subject 6.
Supervised machine learning where the following topics are addressed: introduction to ML and distinction between supervised ML and unsupervised ML. The concept of reinforcement. The main supervised learning techniques. Classification. Support vector machines. kNN algorithms. Regression: linear and linearizable models. Logistic regression for categorical and mixed data.

Subject 7.

Unsupervised machine learning where the following topics are addressed: hierarchical clustering. Principal component analysis. Social network analysis: identifying relationships between individuals and classifications based on relationships. Algorithms for detection of communities in a relational graph.

Subject 8.
Deep learning and Neural Networks where the following topics are addressed: characteristics of deep learning, convolution networks and auto-encoders. Exercise on fuzzy logic, CNN and RBM. Neural Network Theory. The threshold logic unit, the multilayer perceptron, the back propagation. Learning and using a neural network. The use of neural networks in medicine, cyber-security, text and image recognition. Development of neural networks in python and openCV for image processing.

Evaluation system and criteria

The examination consists of a written test. This includes:

- 6 open-ended questions (4 marks each for a total of 24 out of 30 marks).

In addition, two etivities, consisting of exercises and applications in machine learning and AI, need to be sent to the instructor in advance of the examination. Each etivity counts 3 marks for a total of 6 out of 30 marks.

Bibliography and resources

4. *Materials to consult:*

Notes written by the instructor are available in English. The notes cover the course contents, exercises and examination questions.

5. *Recommended bibliography:*

Suggested readings are:

S. Russell, P. Norvig: Intelligenza Artificiale – Un Approccio Moderno. Pearson, 2010.

Y. Bengio: Learning Deep Architectures for AI. In Foundations and Trends in Machine Learning, Vol. 2, No. 1, 2009.

Additional readings will be suggested by the instructor during lessons considering students interests.