UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Probabilistic Models for Decision Making

2526-1-F1802Q106

Aims

The course will provide the main concepts and operative tools, based on computational methods, for representing the learning process and the reasoning techniques in uncertain domains. Students will gain the ability of using the concepts and methods learned for solving practical operational decision problems. In particular, they will acquire the following abilities: to identify relations between parameters by using probabilistic models, to build models for decision making, to evaluate and find the problem solutions.

Knowledge and Understanding (Dublin Descriptor 1)
By the end of the course, the student will be able to:

- Know and understand the main concepts, theories, and methods related to static and dynamic Bayesian Networks.
- Critically analyze the reference models and practical applications of Bayesian Networks.
- Recognize the connections between the different disciplinary areas involved in the course.

Applying Knowledge and Understanding (Dublin Descriptor 2)
The student will be able to:

- Apply the acquired theoretical knowledge to solve specific problems or case studies related to static and dynamic Bayesian Networks.
- Use analytical tools and techniques to design concrete solutions.
- Conduct experiments, practical activities, or simulations.

Making Judgements (Dublin Descriptor 3)
Through laboratory activities, exercises, and report writing, the student will develop:

- Critical skills in interpreting collected data and information.
- The ability to evaluate different strategies and solutions, weighing their advantages and limitations.
- The capacity to formulate reasoned and well-argued judgments independently.

Communication Skills (Dublin Descriptor 4)
During the course, the student will be encouraged to:

- Effectively communicate the results of their analyses both in written form (assignments, reports) and orally (presentations, discussions).
- Use appropriate and clear technical language.

Learning Skills (Dublin Descriptor 5)
By the end of the course, the student will be able to:

- Organize and independently plan their own path of professional development and further study.
- Use bibliographic, digital resources, and self-learning tools to continue studying effectively.
- Develop a critical and reflective approach towards new knowledge and technologies in the field of study.

Contents

Representing uncertainty in decision problems

Knowledge representation in uncertain domains

Bayesian Networks

Pseudo-number generation for sampling

Inference on BN

Probabilistic Reasoning over time

Markov Chains

Hidden Markov Models

Inference in dynamic models

Detailed program

1. "Representing uncertainty in decision problems Basic notions of probability theory Bayes rule and its application". Chapter 13.

   2.1 "Knowledge representation in an uncertain domain Bayesian network semantics; Efficient representation of conditional probabilities". Chapter 14 (14.1, 14.2, 14.3).

   2.2 D-separation (papers & slides)

   2.3 Pseudo-number generation for sampling (papers & slides)

   3. "Exact and approximate inference in Bayesian Networks". Chapter 14 (14.4, 14.5)

   4. "Markov Chains" (papers & slides)

5. Hidden Markov Models; Forecasting, Filtering and Smoothing ". Chapter 15 (15.1, 15.2 15.3).

Prerequisites

Basic notions of: probability, statistics, linear algebra

The course is in Italian.

Teaching form

Lectures, classroom exercises, lab exercises

- 32 lectures of theory of 2 hours each in presence of erogative nature
- 20 excercise lectures of 2 hours each (of which a maximum of 3 hours of interactive lectures in presence and a maximum of 3 hours of interactive lectures on line)

Textbook and teaching resource

S. Russel, P. Norvig. “Artificial Intelligence: A Modern Approach", Prentice Hall, III Edizione

papers & slides

Semester

Second Semester

Assessment method

Written Exam + oral (optional)

Office hours

By appointment

Sustainable Development Goals

INDUSTRY, INNOVATION AND INFRASTRUCTURE