UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

SYLLABUS DEL CORSO

Advanced Data Management and Decision Support Systems

2526-1-F9103Q008

Aims

Module Data Management
The aim of the data management module is to introduce the main conceptual and theoretical tools to manage data. The aim is three-fold: Provide students with the practical and theoretical foundations of data management systems, including issues of data distribution; Illustrate and introduce the main paradigms to structure, store and manipulate data (including both relational and the most important noSQL paradigms); Provide a solid foundation to the basic concepts of large-scale data processing.
At the end of the course, students should have acquired and should be able to prove and communicate sufficient knowledge in the above mentioned topics, in particular (DdD1, DdD4):

- Data management systems' design principles
- Conceptual, logical and physical models for data management
- Data management principles in distributed settings (replication, sharding, distributed consensus solutions, transactions)
- Foundations of large-scale data processing (MapReduce/Hadoop, Spark)

They should also have acquired the ability to apply the taught notions in practical contexts, in particular (DdD2):

- Ability to translate user requirements in data models and how to practically implement these latter
- Ability to practically manage data using different query and data models (SQL, Cipher)
- Ability to implement large-scale data processing pipeline, using tools such as Apache Spark

Finally, they should have reached a sufficient maturity enabling them to autonomously understand up-to-date development in data-management (DdD5), as well as the capacity to critically evaluate different data management solutions, their benefits and limitations (DdD3).

Module Decision Support Systems
The aim of the course is twofold: on the one hand, to introduce students to the main conceptual and theoretical tools to model rational choices in decision making; on the other hand, to provide students with models and tools to

design usable (i.e., effective, efficient and easy-to-use) decision support systems and evaluate them in the real world.

At the end of the course, students should have acquired and should be able to prove sufficient knowledge in the above mentioned topics, in particular (DdD1, DdD4):
- Models and definitions of decision-making
- Theoretical foundations of decision making
- Automation of decision making processes
- Quality dimensions of decision support systems: usability, trust, dependence, compliance, reliance

They should also have acquired the ability to apply the taught notions in practical contexts, in particular (DdD2):
- Ability to formally define and analyze decision-making scenarios
- Ability to design decision support systems
- Ability to evaluate decision support systems

Finally, they should have reached a sufficient maturity enabling them to autonomously understand up-to-date developments in decision-making and related disciplines (DdD5), as well as the capacity to critically evaluate different decision support sytems, their benefits and limitations (DdD3)...

Contents

Module Data Management
Basics of modern data management
Relational and NoSQL data and query models
Distributed data management
Distributed data processing

Module Decision Support Systems
Models and definitions of decisions and decision making
Rationality
Elements of formal decision theory: single agent, multi-agent (game theory and social choice theory).
Automation of decision making processes: usability and user acceptance, trust, dependence, compliance, reliance, biases.

Detailed program

Module Data Management
Basics of Data Management systems (erogative lesson, 1h)
Data Management system design principles: reliability, scalability, maintainability (erogative lesson, 1h)
Data models (relational, key-value, document, graph) and query languages (erogative lesson, 2h)
- Conceptual data model (Entity Relationship model)
- Logical data models (relational, key-value, document, graph)
- Physical data models and storing formats

Practical usage of Relational DBMS and SQL (laboratory lesson, 4h)
Practical usage of NoSQL DBMS (Redis, MongoDB, Neo4J) (laboratory lesson, 4h)

Transactions and ACID properties (erogative lesson, 4h)
Distributed data management (replication, sharding, consensus) (erogative lesson, 6h)
Distributed data processing (map reduce, Hadoop, Spark) (erogative lesson, 2h)
Practical usage of Apache Spark and Map Reduce (laboratory lesson, 4h)

Module Decision Support Systems
All lessons are in erogative form.

- Decision Support Systems (16h)
  Models and definitions of decisions and decision making
  Decision as inference and preference
  Naturalistic decision making
  Heuristic decision making
  Rationality and rational decision making
  Definitions of rational decision
  Normative models
  Descriptive models
  Automation of decision making processes
  Levels and stages of automation
  Trust in, dependence on automation
  Models of user acceptance, trust, dependence, compliance (TAM, UTAUT)
  Decision Biases due to automation

- Elements of formal decision theory (12h)
  Single-agent decision theory (decision under ignorance and under risk) (3h)
  Non-cooperative game theory (3h)
  Coalitional game theory (3h)
  Social choice theory (3h)

Prerequisites

Module Data Management
Basic notion of the relational model, SQL query language

Module Decision Support Systems
Basic notions of probability theory and artificial intelligence, mathematical maturity

Teaching form

Module Data Management
Class-room taught classes (16h), computer-based programming exercises (12h).
All lessons will be held in presence.

Module Decision Support Systems
Class-room taught classes.
All lessons will be in erogative form.
Lessons will be held in presence.

Textbook and teaching resource

Module Data Management
Slides presented by the teachers.

(Suggested) Textbooks
Designing Data-Intensive Applications. Martin Kleppmann. O'Reilly
Principles of Distributed Database Systems. M. Tamer Ozsu, Patrick Valduriez. Springer

Additional materials, readings and resources will be available on the e-learning platform.

Module Decision Support Systems
Slides presented by the teachers.

(Suggested) Textbooks
An introduction to Decision Theory (Second Edition). Martin Peterson. Cambridge University Press
Multiagent Systems. Algorithmic, Game-Theoretic, and Logical Foundations. Yoav Shoham, Kevin Leyton-Brown. Cambridge University Press

Suggested Readings
Katsikopoulos, K., Simsek, O., Buckmann, M., & Gigerenzer, G. (2020). Classification in the wild. MIT Press
Klein, G. (2022) Snapshots of the Mind. MIT Press
Engineering Psychology and Human Performance, Cristopher D. Wickens, Justin G. Hollands, Simon Banbury, Raja Parasuraman. Psychology Press

Additional materials, readings and resources will be available on the e-learning platform.

Semester

2nd semester

Assessment method

Module Data Management
The module has two different (exclusive) exam modalities, that can be selected by the student in accordance with the teacher:

Written exam (open questions) to ascertain understanding of the concepts taught in class.
The students will have to answer to 5 open questions on the contents of the course (all taught contents can be in the exam), where they will be asked to critically discuss different aspects of data management systems. Each question can be graded up to 6 points based on the following requirements: completeness (the student has exhaustively answered to all of the question elements), correctness (the student's answer is correct), communication (the student has demonstrated the ability to think critically about different aspects of the discussed topic).

OR

Project related to the topics of the module AND oral exam to ascertain understanding of the concepts taught in class.
The project can be performed in small groups (up to 2/3 persons, depending on the project) but the oral exam is individual.
The project can be graded up to 27 points based on the following requirements: completeness (the student(s) has exhaustively answered to all of aspects of the project assignment), correctness (the student(s) implementation is correct and exempt of errors), communication (the student(s) has demonstrated the ability to reason critically and report about the produced implementation).
The oral exam consists of three questions on the contents of the course (all taught contents can be in the exam), each of which can be graded up to 3 points.

The module does not have any in-progress tests.

Module Decision Support Systems
Written exam (closed and open questions) to ascertain understanding of the basic concepts taught in class and their relationships (max. grade mark 30), optional original essay for students with a written exam grade >= 18 (max. additional 4 points)

Office hours

Module Data Management
Available by appointment (email: andrea.campagner@unimib.it).
Module Decision Support Systems
Available by appointment (email: andrea.campagner@unimib.it).

Sustainable Development Goals

QUALITY EDUCATION