UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Introduction To Computer Science

2021-1-E3401Q038

Aims

The main objective of the course is to provide fundamental expertise and practical skills on computer science and data analysis, with particular focus on the possible applications to the sphere of geological sciences.

Contents

- The course will allow to:
- Understand what computer science is
- Know the history of computer science
- Understand what computer science is important in geological sciences
- Learning notions related to network technologies, understanding the difference between the Internet and the Web
- Understanding the problem of access to data and information
- Understand the logic and architecture of computers
- Become familiar with the organization, analysis, and visualization of data
- Become familiar with the concept of relational database and SQL query language
- Become familiar with algorithms
- Transform theories into practical applications
- Learn how using Matlab and Excel to develop algorithms, store, process and analyze data, and produce

graphs.

Detailed program

Introduction

- Introduction to the course, organization of lessons and exercises
- What is computer science
- Data and information
- What are the algorithms
- Why computer science for Earth Sciences
- G.I.S. (Geographical Information Systems)

History of Computer Science

- Prehistory and the first "steps" of computer science
- The definition of the theoretical foundations (logic, Boolean algebra, the first programs)
- Electromechanical machines
- Turing's machine
- ENIAC and the ancestors of the digital computer
- Transistors, chips, and microprocessors
- The first personal computers
- Storage and transmission of data (protocols)
- Moore's law
- ARPANET and the path that leads to the Internet
- The dissemination to the general public of computers (first) and the networks (after)

Internet and the Web

- Difference between the Internet and the Web
- The World Wide Web
- Static Web and Dynamic Web
- Web 1.0, 2.0, 3.0, 4.0
- The social Web

The problem of access to information

- Introduction to the problem
- Search engines
- Recommendation systems
- Access to information on social media
- Analysis of data on social media

Computer networks

- The components of a computer network
- Network classification by extension
- Classification of networks by topology
- Network classification by transmission medium
- Communication protocols
- Internet and Internet of Things
- Internet services: Web, e-mail, DNS

The representation of data in the binary system

- The numerical systems
- The decimal system
- The binary system
- Conversion of numbers to different bases
- Signed number representations
- The representation in two's complement
- Boolean algebra and electronic circuits

The coding of texts, images, and sound

- The representation of the text
- The characters
- The ASCII and Unicode representation systems
- The representation of images
- Raster graphics
- Vector graphic
- The representation of sound
- Audio sampling
- Audio quality in digital representation

Computer architecture

- The hardware
- The architecture of Von Neumann
- CPU, Memory, I / O, BUS
- The software
- The operating system

Databases and the relational model

- Data and information
- Informative system
- The computer system
- Databases
- Database management systems
- The relational model

- Relationships between tables (one to one, one to many, many to many)

The SQL language

- Schema and instance definitions in SQL
- Syntax and elementary domains
- Interrelational constraints
- Projection and selection
- Selection of data from multiple tables

Introduction to algorithms and programming

- What is an algorithm
- The properties of the algorithms
- Flow charts (conditional instructions and cycles)
- The pseudocode
- Programming languages
- Programming paradigms

Procedural languages

- Variables and constants
- Assignment instructions
- Data types (elementary and derivatives)
- Functions
- Control structures (conditional and iterative)

Introduction to MATLAB - First part

- Summary of the fundamental concepts of procedural programming
- Algorithm example (flow chart, pseudocode and MATLAB code)
- Description of the MATLAB programming environment
- Basic use
- The variables in MATLAB

Introduction to MATLAB - Second part

- Scalar values, vectors, and matrices in MATLAB
- Initialize vectors and matrices
- Access elements of vectors and matrices
- Matrix operations
- The operators in MATLAB (arithmetic, comparison, logic)
- The control structures in MATLAB (if-else, switch-case, while, for)

During the Exercises, the use of Excel and its main functions will be illustrated in practice, and the use of MATLAB for the definition of algorithms for data processing and analysis will be discussed in depth.

Prerequisites

None

Teaching form

- **Lectures** (Dr. Marco Viviani)
- **Laboratory exercices** (turno "A-G" [TUGE**A**]: Dr. Davide Maspero; turno "H-Z" [TUGE**B**]: Dr. Giuseppe Dattola)

- The course is delivered in **Italian**

Textbook and teaching resource

Suggested **textbooks (in Italian language)**

Fundamentals of computer science

- Informatica. Una panoramica generale J. Glenn Brookshear Pearson
- Informatica arte e mestiere. MacGrawHill

MATLAB

- Munther Gdeisat, Francis Lilley. Matlab by Example. Programming Basics 2013. Elsevier
- M.H.Trauth - MATLAB Recipes for Earth Sciences. Springer
- Dave Heslop. An Introduction to MATLAB for Geoscientists, 2012. Risorsa Online

Software (compulsory)

Software available with *unimib* licence:

- MATLAB (Windows/Mac): https://unimibit.sharepoint.com/portale/service-desk/SitePages/Area%20download%20-%20Studenti.aspx
- Microsoft Excel (Windows/Mac)

Please access with unimib user and password at your personal page.

Semester

March - June 2020

Assessment method

- **Computer test (in a laboratory or online):** theoretical questions + practical exercises
    - 5 questions with multiple choice for the extensive control of theoretical and theoretical-practical concepts illustrated in class
    - 3 open questions for intensive preparation control on the exam program (theoretical aspects)
    - 3 exercises for verifying the learning of using Excel, the knowledge of the SQL language, the fundamental concepts of programming using MATLAB.
- **Oral test** (optional)

Office hours

By appointment:

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