UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Large-Scale Graph Algorithms

2526-2-F1801Q162

Aims

The course will present some efficient algorithms concerning fundamental problems in graph theory.
Moreover, we will discuss some computational complexity aspects and the related algorithm design techniques, as well as techniques for implementing efficient (and heuristic) algorithms on large-scale graphs.

Knowledge and understanding
Student will learn how to represent standard graphs and large-dimension graphs, and they will learn some fundamental graph algorithms and heuristics techniques to tackle computational problems on small and large graphs.

Applied Knowledge and Understanding
At the end of the course, students will be able to model a real-world problem in terms of a graph problem, and to design specific algorithms to efficiently solve the problem.

Independent Judgment

Students will be able to understand which algorithms are most appropriate for solving specific problems.

Communication Skills

Students will be able to formally describe a proof, an algorithm, or the mathematical modeling of a problem.

Learning Skills

Students will be able to fully understand new algorithmic techniques.

Contents

Graph theory fundamentals.
Computational problems on graphs.
Heuristic approaches on large-scale graphs.

Detailed program

- Graph: basic notions. Representation of graphs: adjacency lists, adjacency matrices. Efficient and succint data structures for graph representation.

Graph problems

1. Connected components, bi- and tri- connected components
2. Graph matching
3. Cuts and flows
4. Minimal cover, maximum clique, maximum independent set
5. Eulerian path, Hamiltonian path, and Travelling Salesman Problem (TSP)
6. Graph coloring
7. Graph isomorphism
8. Graph compression
9. Graph planarity and graph drawing

Heuristic techniques and computational complexity

1. Parametric complexity. Graph cover algorithms
2. SAT solvers
3. Lin-Kernighan algorithm
4. Simulated Annealing
5. Approximation complexity
6. Particle Swarm Optimization
7. Streaming Algorithms
8. Ant Colony

Prerequisites

Theory of computation

Teaching form

All activities are in-person and will be neither recorded nor streamed. The teaching language of this course is English. The activities will be:

- 24 lectures, 2 hours each, with an initial part in unidirectional mode and a second part in interactive mode.

Textbook and teaching resource

The text we will be using is Graph Algorithms, a collection of readings compiled from Wikipedia.

Lecture materials will not be distributed to the class; instead, you are encouraged to attend the lecture yourself and take your own notes.

Semester

First semester

Assessment method

The exam consists of an oral exam, with open-ended questions over all topics of the course.

The main criteria to evaluate the exam are correctness and completeness of the answers. Secondary criteria are the correct use of formal aspects and the ability to discuss how the answer is related to different course topics. Beware that you must be registered via "segreterie online" to take the exam. If you are not registered, you will not allowed to take the exam. No exceptions will be made.

Office hours

Office hourse are online.
You can book a meeting at:

- https://www.unimib.it/gianluca-della-vedova
- claudio.zandron@unimib.it

Sustainable Development Goals

GOOD HEALTH AND WELL-BEING | INDUSTRY, INNOVATION AND INFRASTRUCTURE | SUSTAINABLE CITIES AND COMMUNITIES