Advanced Algorithms

Floriano Zini
Free University of Bozen-Bolzano
Faculty of Computer Science

Academic Year 2013-2014

Contact details

- Floriano Zini
  - Faculty of CS, POS 2.19
  - floriano.zini@unibz.it
  - http://www.inf.unibz.it/~zini/

- Office hours
  - Friday, 11:00am -12:00pm

- Course web site
  - http://www.inf.unibz.it/~zini/AA
Course structure

- Credits: 4
- Lectures: 24 hours
- Labs: 12 hours

Timetable
- Lectures: Friday, 8:30am-10:30am, D002 Lecture room, Ser-D
- Labs: Friday, 2:00pm-3:00pm, E331 Computer room, Ser-E

Please check the course webpage and/or the online timetable for variations

Assessment

- Project (P) – maximum 14 points (40% of mark)
  - In a team of maximum 2 students
  - A positively assessed (i.e., at least 8 points) project is required for taking the final exam!!
    - A passed project counts for the 3 regular exam sessions
- Final exam (E) – maximum 16 points (60% of mark)
  - Written questions and exercises
- Optional assignments (A) – maximum 2 points
- Final grade (G)
  - \( G = E + P + A \)
  - To pass: \( P \geq 8 \) points and \( E \geq 10 \) points
Goals of the course

- We will focus on various *paradigmatic computational problems* arising from real world scenarios.
- We will see a range of *efficient algorithms* to solve these problems.
  - Algorithms for *special kinds of problems*.
  - Algorithms that are *powerful and general*.
- We will learn how to *implement* some (or parts) of the introduced algorithms.
- We will see *practical applications* of the presented algorithms.

Learning outcome

- Increase your *knowledge* about advanced *paradigms* of *algorithm design*.
- Introduce the most useful and powerful *information structures* along algorithms for solving some relevant problems.
- Study some *core computer science problems* that have a large applicability in several different areas.
- Enhance your *ability* to select the best and efficient way for *encoding problems*.
How?

- **12 two-hours frontal lectures**
  - theory, examples, and quizzes
- **12 one hour labs**
  - Exercises (fundamental for the written exam!)
  - Java and or MATLAB®/Octave will be used by the students to implement (parts of) the algorithms presented in the lectures
- **Homework**
  - Studying the slides is not enough
  - The students should also
    - Study on the suggested books
    - Do the proposed exercises and assignments
    - Ask questions in class or during the office hours

Syllabus

- Elements of complexity theory
- Algorithms with numbers
- Elements of graph theory
- Greedy algorithms
- Linear programming and simplex algorithm
- Network optimization algorithms
- Approximation algorithms
- Randomized algorithms
- Evolutionary algorithms
- Algorithms for linear and logistic regression
- Online algorithms
Course material

- Course slides
  - Available at [http://www.inf.unibz.it/~zini/AA](http://www.inf.unibz.it/~zini/AA) the day after the lecture

- Textbooks
  - *Algorithms*
      - Copies are available in the library
      - A draft copy is available on the web: [http://www.cs.berkeley.edu/~vazirani/algorithms.html](http://www.cs.berkeley.edu/~vazirani/algorithms.html)
  - *Introduction to Evolutionary Computing*
    - by Gusz Eiben, Jim Smith, Springer 2003

- Other useful material
  - Online lectures ([https://class.coursera.org/ml/lecture/preview](https://class.coursera.org/ml/lecture/preview))
    - by Andrew Ng ([http://cs.stanford.edu/people/ang/](http://cs.stanford.edu/people/ang/))
    - on Coursera ([http://www.coursera.org/](http://www.coursera.org/))

Project

- The project is conducted **individually** or in **small groups** (2 students)
- **Choose** the **advanced algorithm** you like the most
- **Implement** it (or part of it) using Java or MATLAB®/Octave
- **Validate** the implementation on some use cases
- **Research 3 real word application** on which your champion algorithm has been applied
  - Explain how the computational problem underlying each application has been **modeled** to be treated with the algorithm
  - Explain which are the **reasons** why the algorithm has been chosen for each 3 applications and **critically analyze** pros and cons of the choice
  - **Compare and contrast** the selected algorithm with other algorithms for realizing the same 3 applications
- The project **results** include:
  - A **written report** of not more than 4,000 words
  - An **algorithm implementation**
Project – structure of the report

- Executive summary
- 1 section including the description of the selected algorithm
- 1 section describing how you have implemented it (e.g., provide the class and interaction diagrams and describe them, or describe the MATLAB®/Octave functions)
- 1 section for each of the 3 real world applications on which the algorithm has been applied
  - 1 subsection including the description of the application and how it has been modeled to be treated with the algorithm
  - 1 subsection including the reason why the algorithm has been applied to the application and critical analysis of pros and cons of the choice
  - 1 subsection that compares and contrasts the selected algorithm with other algorithms for realizing the same application
- 1 section including conclusions and observations
- Citations to the scientific papers and other material you reference in the report

Project – evaluation

- Submit 1.5 pages draft with your idea I’ll revise it (we’ll decide a deadline)
- The report must be compliant with the structure defined in the previous slide
- The writing must be clear and neat
- The report must show that you have:
  - Well understood the selected algorithm
  - Deeply analyzed its application to the 3 specific fields
  - Compared in details the algorithms with other approaches
- The project results will be presented in a seminar (15 mins for each presentation) in front of the class
  - The presentation must be understandable and raise the audience attention
  - The presenters must be able to reply to the questions of the other participants
Acknowledgements

- Part of the slides are adapted from those by **Valeria Fionda** (Free University of Bozen-Bolzano)
- Other slides are adapted from those by **Yijia Chen** (Shanghai Jiaotong University)
- Some material comes from the Machine Learning online course by **Andrew Ng** (Stanford University) available on Coursera
- The organization of the course takes inspiration from **Francesco Ricci** (Free University of Bozen-Bolzano)