Course: Analysis of Algorithms and Heuristic Problem Solving

2021/22, Spring Semester

Lecturer: Prof Dr Marko Robnik-Šikonja
Assistant: Assist. Dr Matej Pičulin

Objectives

The goal of the course is the students to become acquainted with the analysis of algorithms, computational complexity and techniques for efficient solving of difficult problems, requiring optimization techniques and approximations.

Students' obligations:

- on-time submitted quizzes, obtaining at least 50% of points altogether,
- on-time submitted 5 assignments, obtaining at least 50% of points for each assignment,
- written exam.

Grading

Seminars/Labs

Seminars are in the form of consultations. Please, prepare questions and bring in problems you encounter during your individual work. Altogether, there are 5 graded seminar assignments. Each assignment has to be submitted on time and graded with at least 50% of points. To pass the exam one also has to get at least 50% of points (altogether) in the quizzes. There is a zero tolerance policy in case of plagiarism.

Exam

One A4 sheet of paper is allowed during the written examination. At least 50% of points is required to pass the exam. An oral exam is optional and allowed to students passing written exam who try to improve the grade. Any suspect of plagiarism results in obligatory oral exam for everybody involved.

Final grade

The course grade is composed of seminar grade (50%) and written exam (50%).

Syllabus outline

Lecture topics:

1. Analysis of recursive algorithms: recursive tree method, substitution method, solution for divide and conquer approach, Akra-Bazzi method.
2. Probabilistic analysis: definition, analysis of stochastic algorithms.
3. Randomization of algorithms.
4. Amortized analysis of algorithm complexity.
5. Solving linear recurrences.
6. Analysis of multithreaded, parallel and distributed algorithms.
7. Combinatorial optimization, local search, simmulated annealing.
8. Linear programming for problem solving.
9. Metaheuristics and stochastic search: guided local search, variable neighbourhood search, and tabu search.
10. Memetic algorithms, particle swarm optimization.
11. Differential evolution, artificial immune systems.
12. Exotic optimization algorithms: grey wolf, whale, bees, etc.
13. Machine learning in combinatorial optimization
14. Practical optimization problems.

Readings

T.H. Cormen, C.E. Leiserson, R.L. Rivest, C. Stein: *Introduction to Algorithms, 3rd edition*. MIT Press, 2009
M. Gendreau, J-Y. Potvin (Eds.): *Handbook of Metaheuristics*, 2nd edition. Springer 2010

Further readings:
R. Sedgewick, P. Flajolet: *An Introduction to the Analysis of Algorithms.* Addison-Wesley, 1995
M. Sipser*: Introduction to the Theory of Computation. 2nd edition*, Thomson, 2006
S. Arora, B. Barack: *Computational Complexity - A Modern Approach*. Cambridge University Press, 2009