Course: Analysis of Algorithms and Heuristic Problem Solving

2024/25, Spring Semester

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

Objectives

The goal of the course is for the students to become acquainted with the advanced analysis of algorithms 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 five 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 five 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 double-sided sheet of paper is allowed during the written examination. At least 50% of points are required to pass the exam. An oral exam is optional and allowed to students passing written exams who try to improve their grades. Any suspicion of plagiarism results in obligatory oral exams for everybody involved.

Final grade

The course grade is composed of a seminar grade (50%) and a 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 and 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, simulated 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.
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 or 4th edition*. MIT Press, 2009 or 2022
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