Exercises for the course

Heuristic Optimization

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Exercise sheet 5

Exercise 5.1

Assume we organize a "competition" for the travelling salesperson problem with time windows. As a price, the winner obtains a bottle of champagne and a final mark of 20. Discuss all aspects so that you consider the determination of the winner as being fair. In other words, how would you organize such a competition? Justify your reasoning.

Exercise 5.2

Two possible approaches to the automatic configuration and tuning of metaheuristic algorithms are *offline* and *online* tuning approaches. Discuss the advantages and disadvantages of each one of these approaches. For which application scenarios would you choose each of these approaches.

Exercise 5.3

Discuss possible ways of combining offline and online tuning approaches.

Exercise 5.4

Automatic algorithm configuration techniques can be useful to support comparative, empirical studies of metaheuristic algorithms to avoid uneven tuning of algorithms. Outline possible approaches of how to use such techniques in empirical studies. How would you take into account the fact that the number of parameters for algorithms can differ very much?

Exercise 5.5

Explain why it is possible that for a family of instances of a given combinatorial problem, the number of solutions increases exponentially, while the solution density decreases exponentially, as instance size increases.

Exercise 5.6

Prove that the neighborhood graph of a SAT instance under the 2-flip neighborhood in which neighboring assignments differ in the truth value of exactly two variables is disconnected. Which conclusion can you draw from this fact?

Exercise 5.7

Give an example for a landscape that has no local minimum other than the global optimum and is yet very hard to search for any standard SLS method.

Exercise 5.8

For a new optimization problem you should tackle you know that the problem instances usually show large fitness-distance correlation. What implications does this knowledge have on the design of iterated local search algorithms?

Exercise 5.9

Assume that a bi-objective problem is tackled by a weighted sum aggregation. Show that the obtained trade-off points lie on the convex hull of the Pareto-front in case an optimal solution for each weight vector is found.

Exercise 5.10

Assume that you use iterative improvement algorithms for each scalarization in the SAC search model and a multi-objective iterative improvement algorithm in the CWAC search model. What do you expect how properties of the final Pareto front (spread, number of solutions) impact the computation times of these algorithms?

Exercise 5.11

One may measure the correlation between objective functions in multi-objective problems by sampling solutions (e.g. randomly or after some optimization) and then measure the correlation between the objective vectors. What impact do you expect from different observed correlations on properties of the Pareto front (spread, number of solutions)? For simplicity, assume two objective functions. Consider what high positive, high negative, and zero correlation would mean for bi-objective minimization problems.