Efficient algorithms for finding maximum induced acyclic subgraph in directed graphs

In the Maximum Induced Acyclic Subgraph (MIAS) problem we are given a directed graph, and the goal is to find the largest possible vertex set which induces an acyclic graph. The problem is equivalent to the feedback vertex set problem in directed graphs, a well known algorithmic problem.

The MIAS problem has applications in real-world problems. To the most important ones we can include the deadlock detection problem in parallel processing, where the problem of finding a large induced acyclic subgraph plays an important role in the deadlock recovery process. The MIAS problem has also significant impact in the field of very large-scale integration circuits and chip design, relevant in some industrial areas. It is also important from the theoretical point of view, especially in the context of parameterized algorithms.

The MIAS problem is computationally difficult. Even when compared to some other, similar graph problems, the MIAS problem seems to be much more complicated. The running time complexity of fastest known to date algorithms for finding optimal solution makes them rather impractical. This does not mean, however, that solutions of high quality cannot be found in practice. Such solutions can be determined using heuristic methods. It may even be possible to find optimal results, even for very large graphs, as some used methods may (but need not) produce provably optimal results. One of such methods is application of data reduction rules, which can significantly reduce the size of processed data and notably speed up the whole problem solving process. It is not uncommon to obtain even optimal results using data reduction rules only. Heuristic approaches are the most common and effective ways of solving difficult problems in practice. Though it may not be possible to find a best possible solution to a problem, it is usually not required, and a high quality of a found solution is sufficient for real-world applications.

The goal of the project is to design and implement efficient algorithms for finding high-quality solutions for the MIAS problem in a reasonable (from practical point of view) time. Particular stress will be put on the design of data reduction rules and efficient heuristic methods. Both approaches have proven to be very efficient in practice for many other combinatorial problems, and we expect to find algorithms working well for the MIAS problem as well.