

Metaheuristics for the Asymmetric Hamiltonian Path

J. P. Pedroso

We are dealing with the following problem: given an operation currently being done in a machine, determine the order for the set of operations to be produced next, such that the total production time is minimized. We assume that there are no precedence constraints among the operations, but there are changeover times which depend on the production sequence. Minimizing the total production time is equivalent to minimizing the time spent in changeovers, as the other times are constant.

This problem has practical relevance. In paint production, the machine cleaning times are usually dependent on the sequence; for example, producing white colour after grey requires a much more careful cleaning than the other way around. Another practical application is in food manufacturing, where strong flavours can be produced after flavourless products at a small cost, but very careful and lengthy cleaning is required in the inverse situation.

One possibility for modelling this problem is to consider a graph with a node for each of the items that must be produced. There are two arcs between every pair of nodes, one in each direction, representing the changeover time between the corresponding products. A solution to the original problem corresponds to determining a Hamiltonian path in this graph, i.e., a path going through all the nodes in the graph. The path must start with a particular node (the item being currently produced), but there is no concern about the ending node.

Given the similarity of this problem with the Travelling Salesman Problem, in particular with its asymmetric variants, we considered adapting the methods that have been developed for that problem to the current situation. Throughout this paper we will describe more formally the problem in mathematical programming, explain in detail the metaheuristics that we implemented for solving it, and present the results of applying it to a set of benchmark problems.