Large Neighbourhoods in Graph Colouring Problems: An Empirical Analysis

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The usage of large neighbourhoods in local search algorithms has received considerable attention in recent years. Here we explore the extension of local search algorithms for graph colouring problems using exponential sized neighbourhoods and we present one negative and one positive example.

For the classical vertex colouring problem we used a very large scale neighbourhood structure that is examined by a dynamic programming algorithm. This new neighbourhood has favourable analytical properties and is shown empirically to improve the solution quality returned by an iterative improvement algorithm. Yet, when embedded in more powerful stochastic local search (SLS) algorithms and when taking computation time into account, a deterioration of the SLS algorithm's performance results. Several heuristic pruning rules, introduced to speed up the examination of the neighbourhood, have not been sufficient to make clear benefit of the very large scale neighbourhood.

The graph set T-colouring problem (GSTCP) is a generalisation of the vertex colouring problem, where to each node a number of colours have to be assigned such that they respect separation distance constraints within each node and between nodes connected by an edge. For the GSTCP we examined a large scale neighbourhood that considers the reassignment of the colours at a node. This neighbourhood is examined by a randomised recursive procedure. We found that on several classes of GSTCP instances, a tabu search algorithm in the canonical one-exchange neighbourhood is profitably enhanced by this randomised recursive procedure.