Institut for Matematik & Datalogi
Syddansk Universitet

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JBJ

DM63 Meta-heuristics — Ugeseddel 2

Future lectures

We decided to meet only on thursdays, except for 1-2 wednesdays which I will announce in due time.

Lecture on September 8, 2005

I will briefly discuss the branch and bound method (which many of you know from DM19, and which we will not use in the project) I will illustrate it on the graph partitioning problem as well as the TSP problem. Then I introduce the simulated annealing approach. The notes pages 7-14. English speaking attendees, see Reeves chapter 2. At the next lecture I will also discuss the paper "Optimization by simulated annealing: an experimental evaluation; part I, Graph partitioning"by D. S. Johnson et al, *Operations research* **37** (1989) 865-892. This is included in the notes as pages 81-108. **You should read these pages!**

The test-data on which the paper is based can be found on the course page.

Exercises:

1. Besides the methods suggested on the last weekly note for generating testdata, you may also try the following: generate a random graph $G = (V, E)$ with edge probability p and a random partition of V into two sets of equal size. Now delete edges across the partition with a fixed probability q. Repeat this a couple of times from a new random partition of the resulting graph. The result should be a graph which is still random-like but where some cuts are much smaller than the expected number for the starting random graph G.

2. Implement the following **construction heuristic**: Start with two vertices x and y that are not joined by an edge. Let $X := \{x\}$ and $Y := \{y\}$ and now place every other z one by one in the "best" set among the current X and Y, with the restriction that we always have $|X|, |Y| \leq |V|/2$. Repeat the process from various starting choices x, y. Compare the results of this heuristic with those found by Descent and Steepest Descent.

3. Try to experiment with non-balanced solutions. That is let your neighbourhood of a solution s be all those partitions that can be obtained by moving one vertex to the other side. This must involve using a penalty factor, i.e., now the objective function is of the form # edges across the cut plus $\alpha(|X| - |Y|)^2$. This way solutions that are very unbalanced are less likely than some that are closed to being balanced and by choosing α appropriately we do allow the search to visit infeasible solutions. Of course in the end you must rebalance the current partition. Think about how to do this (see also the paper by Johnson et al.). Try to see whether it is possible to improve on the results obtained by Descent etc if imbalance is allowed.

4. Make a variant of Steepest Descent in which, when the algorithm has reached a local minimum, you swap a fixed number k (say 3) of elements from the final set X with k from Y and then restart the algorithm from the new partition. Does it give better results.

5. Try the idea above on the Lin-Kernighan algorithm.