Technische Universität Berlin
Institut für Mathematik

Wintersemester 11/12

Computational Integer Programming

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Exercise sheet 3

Deadline: Thu, 10 Nov. 2011, by email to `steffy@zib.de`

Exercise 1. **10 points**

Use ZIMPL to model the TSP using the Miller Tucker Zemlin (MTZ) formulation. The MTZ formulation adds one additional variable u_i for each city i and some additional constraints. These new constraints, along with the degree inequalities (the tour enters and leaves each vertex exactly once) give a correct model for the TSP, without requiring any of the subtour elimination constraints. The MTZ constraints are added to ensure that the u variables define an ordering of cities in the tour. One city is fixed as the starting city (e.g. $i = 1$) and $u_1 := 1$ and then constraints are added to ensure that $u_j \geq u_i + 1$ whenever arc (i, j) is followed by the tour and $j \neq 1$. These constraints can be expressed by assigning variable bounds $u_1 = 1$, $2 \leq u_j \leq n$ for $j \neq 1$ and constraints $u_i - u_j + 1 \leq n(1 - x_{ij}) \forall i, \forall j \neq 1$. The model file `tspmtz.zpl`, posted on the webpage, will give you a start.

Exercise 2. **10 points**

Another way to model the TSP as an integer program with a polynomial number of constraints is by using network flows. We can embed a single commodity flow problem in the network with a new set of flow variables. An arbitrary vertex is selected as a source with a surplus of $(n - 1)$ units and all additional vertices have a demand of 1 unit. Constraints are added that only allow flow to travel on arcs that are selected by the TSP tour, ensuring that there can be no subtours. Create a ZIMPL model of this formulation. The model file `tspflow.zpl` gives you a start.

Exercise 3. **10 points**

Create a model that can solve the instance given by `berlin52.dat` as quickly as you can. For example, try including some subtour elimination constraints to strengthen the formulations you implemented in Exercises 1 and 2.

Note: Each group should email the three ZIMPL models to `steffy@zib.de` by Thu, 10 Nov 2011. There is no written part to hand in for this assignment.