Technische Universität Berlin
Institut für Mathematik

Wintersemester 11/12

Computational Integer Programming

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Exercise sheet 2

Deadline: Thu, 3 Nov 2011, **16:15 in MA 313**

Exercise 1. **10 points**

(a) Write a model for the traveling salesman problem (TSP) in ZIMPL that explicitly includes all subtour elimination constraints. Note: this model is already given in the ZIMPL user guide V3.1, section 6.2. Solve the instance defined by `germany18.dat`. Write down the optimal tour and cost.

(b) The model given in the ZIMPL user guide uses the *inner* form of the subtour elimination constraints: for each nontrivial subset of cities S a tour must use at most $|S| - 1$ of the edges $\{e_{ij} | i, j \in S\}$. An equivalent formulation, called the *outer* form of the subtour inequalities, says that for each nontrivial subset of cities S a tour must use at least 2 of the edges on the boundary of S, edges e_{ij} with $i \in S, j \notin S$ (or $j \in S, i \notin S$). Adjust your ZIMPL model to use the outer form of the subtour inequalities and solve the resulting model.

Exercise 2. **10 points**

(a) Adjust the model from problem (1a) and add "`, separate`" after the subtour inequality constraints (i.e. change "`subto: no_subtour: ... ;`" to "`subto: no_subtour: ... , separate;`"). This will instruct SCIP to not add all of the constraints to the problem immediately, instead they will be stored in a list and then checked and added dynamically if they are violated. Solve the model, does this improve the speed?

(b) Take the ZIMPL model from exercise (1a) and remove all subtour inequalities. Solve the resulting model. Write down the cost and draw the solution on one of the provided maps. Based on the solution, identify some constraint(s) to forbid the subtours that occur in your solution. Add these new constraints to your ZIMPL model and solve the problem again. Repeat until a valid TSP tour is identified (do not worry, this should only take a few iterations). Draw the solution at each step on one of the provided maps and list the cost at each step.

(c) How many subtour inequalities did you add before solving the TSP instance was solved? How did the solution time of this model compare to the time required to solve the instance in problem (1)?

Note: Each group should email the two models (from 1(b) and 2(b)) to `steffy@zib.de` by Thu, 3 Nov 2011. The written part can be returned in class. (one per group)


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