Mathematical Programming
Programming Exercise Report 2

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1 Model

Objective function

$$\min \Sigma_{e \in E} w_e x_e$$

Make sure that we have a connected tree, thus we only select arcs from nodes which have some selected incoming arc.

$$\Sigma_{(i,j) \in \delta^-(j)} a_{ij} \geq a_{jk} \qquad \forall j \in V, \forall (j,k) \in \delta^+(j)$$

Linking constraints for arc and edge variables, which also ensure that we at most select one arc between all adjacent nodes

$$a_{ij} + a_{ji} \leq x_e \qquad \forall e = (i,j) \in E$$

Make sure that we select k arcs

$$\Sigma_{(i,j) \in A} a_{ij} = k$$

Make sure that we do not select any arc back to the artificial root node

$$a_{i0} = 0 \qquad \forall i \in V$$

Make sure that we only select one of the artificial zero-weight arcs from the root node

$$\Sigma_{(0,i) \in \delta^+(0)} a_{0i} \leq 1$$

Cycle elimination constraints

$$\Sigma_{e \in C} x_e \leq |C| - 1 \qquad \forall C \subseteq E, |C| \geq 2, C \text{ forms a cycle}$$

Edge selection variables

$$x_e \in \{0,1\} \qquad e \in E$$

Arc selection variables

$$a_{ij} \in \{0,1\} \qquad (i,j) \in A$$

	|V|	K	Objective	Runtime in Seconds	B&B Nodes	User Cuts
g01	10	2	46	0.09	0	0
		5	447	0.02	0	0
g02	20	4	373	0.05	0	0
		10	1390	0.08	0	2
g03	50	10	725	0.03	0	1
		25	3074	0.39	32	17
g04	70	14	909	0.20	12	6
		35	3292	0.28	4	11
g05	100	20	1235	0.25	2	7
		50	4898	1.16	341	50
g06	200	40	2068	6.58	1081	45
		100	6705	11.22	1,348	138
g07	300	60	1335	5.08	24	8
		150	4534	19.25	64	35
g08	400	80	1620	11.56	8	13
		200	5787	182.39	5,505	252

Table 1: Results on a Intel Core i7-5500U 2.4GHz

2 Results

3 Separation Method

4 Interpretation of Results