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Computer Course Linear Programming

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Exercise: Carsharing

Exercise 1.1 (Carsharing)
A car sharing company in Munich has a fleet of 100 vehicles. The company has partitioned its business area into a total of 10 zones, each identified by a "hot spot" (i. e., a 2d coordinate) around which cars are ideally distributed.

Car rentals are predominantly done between 6:00 a.m. in the morning and 23:00 p.m. in the night.

However, due to asymmetric customer behavior, the distribution of cars over the zones has changed over the day and does not meet the desired distribution that is optimal in order to meet the rental demand in the next morning ! Thus, in order to re-establish a good distributions of cars over the zones, cars are redistributed over night by employees and distributed around the zone hot spots.

The table below yields the hot spots for each of the zones, the number of cars that should ideally be brought to that zone till the next day and the number of cars that are currently in that zone.

For sake of simplicity, we may assume for this exercise that all cars are more or less exactly located at the hot spots and that this operation is neither affected by other rentals over the night nor any service requirements of the cars (such as filling up gas).

Zones	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
x coordinate	0	20	18	30	35	33	5	5	11	2
y coordinate	0	20	10	12	0	25	27	10	0	15
target amount at 6am	12	7	8	11	10	9	15	7	9	12
given amount at 11pm	10	13	5	8	12	4	14	12	15	7

Relocating a car from one zone to another may be (in this exercise) well-approximated by considering 0,70 per kilometer when taking the driving distance between the hot spots. This may be regarded to be the euclidean distance multiplied with a factor of 1.5.

Which cars should be brought from which zone to which destination zone in order to achieve the target distribution and such that costs are minimized?

a) Formulate the problem as an integer linear program. Implement your model in Python and Gurobi and solve it. Provide a plan of transportation for the vehicles. This plan should include how many cars from which zone are taken so some another zone for all necessary car relocations.

b) Drop the integral constraints. How has the solution changed?