Integer Programming Example #1 - Combinatorics

Three railway wagons with a carrying capacity of 100 quintals (1 quintal = 100 kg) have been reserved to transport sixteen boxes. The weight of the boxes in quintals is given in the following table. How shall the boxes be assigned to the wagons in order to keep to the limits on the maximum carrying capacity and to minimize the heaviest wagon load?

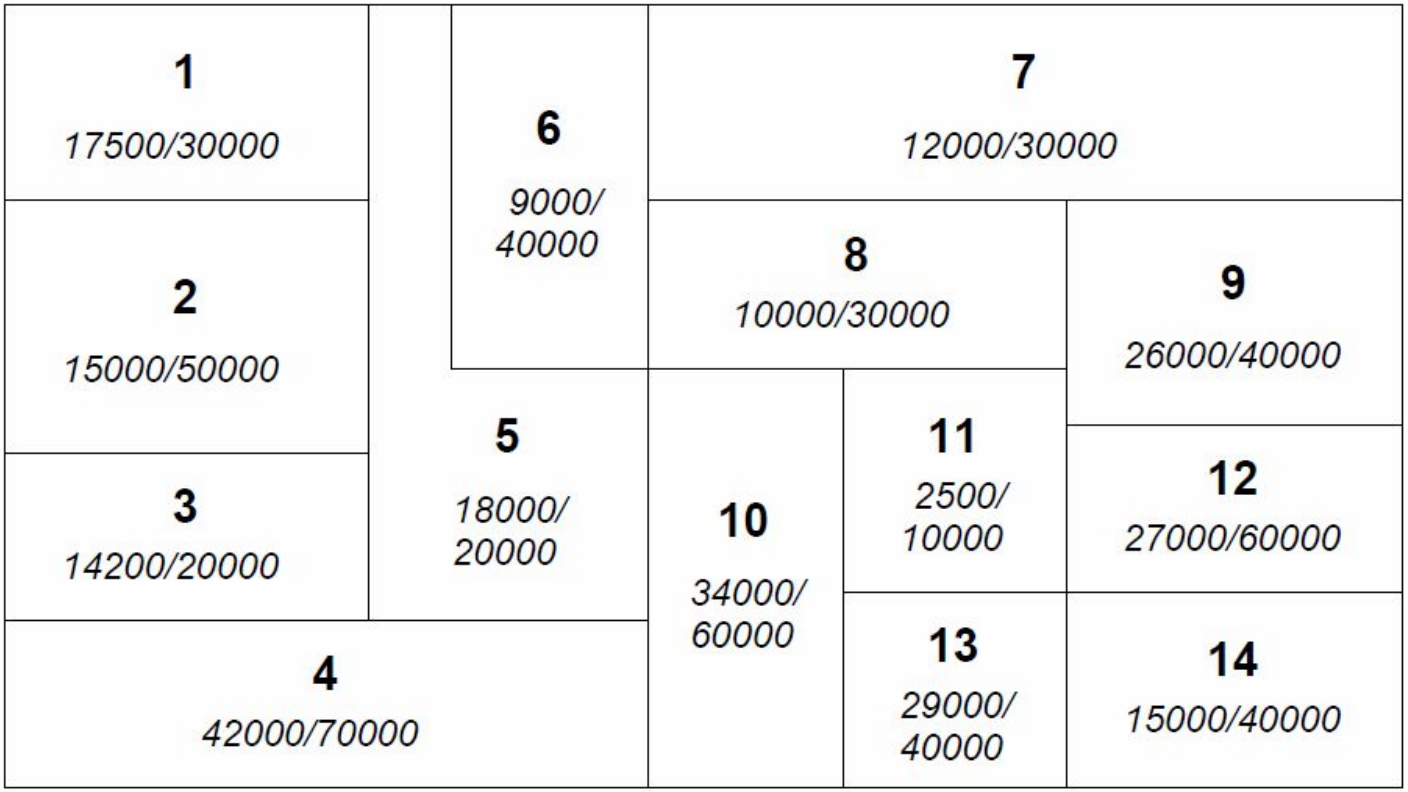
Table 9.1: Weight of boxes

Box	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Weight	34	6	8	17	16	5	13	21
Box	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Weight	25	31	14	13	33	9	25	25

Before implementing a Mathematical Programming solution, one may wish to try to see whether it is possible to solve this problem instance with the following simple heuristic: until all boxes are distributed to the wagons we choose in turn the heaviest unassigned box and put it onto the wagon with the least load.

I formulated this problem in class. Solve it in MPL.

Districting Problem



Numbers are *supporters / total population*

District must contain >= 30,000 and <= 100,000

District with single quarter allowed in population >= 50,000

District must contain adjacent quarters if number quarters > 1

Districting Problem Homework

- **The MPL code my formulation is on Moodle.**
  - Download it and solve it in MPL using CPLEX
  - How many districts are built? How many have majorities?
- **First question:**
  - I had to add a set of constraints to get the number of majority districts right. Find those constraints and explain why I had to add them.
- **Second question:**
  - The optimization, as written, doesn't minimize the total number of districts. So, 6 districts with 4 majorities is better than 9 districts with 5 majorities.
  - Modify the MPL formulation to limit the total number of districts. Find the minimum number of districts that can be built (MPL will be infeasible if you set the limit too low).
  - Vary this limit to find the best *ratio* of majority districts to total districts.