

A resectorization of fire brigades in the north of Portugal

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Is the sectorization of Portuguese fire brigades already optimised?

Using the current sectorization, the geographic and population characteristics and the fire brigades' response capacity we provide an optimised resectorization, to decrease rescue time.

Sectorization: division of a region into smaller regions.

Resectorization: to achieve another division of a region according to some new conditions but avoiding substantial changes, maintaining some degree of similarity between the solutions.

Capacity of each fire brigade (c_i):

$$c_i = 0.5g_1A_i + 0.3g_2V_i + 0.2E_i$$

A_i - number of ambulances in brigade i
 V_i - number of fighting vehicles (forest and industrial) in brigade i
 E_i - adimensional number of firefighters in brigade i
 g_1, g_2 - constant parameters

Demand of each subregion (s_j):

$$s_j = 0.6P_j + 0.4Q_j$$

P_j - adimensional population in subregion j
 Q_j - adimensional area of subregion j

Sectors must be:

- **Balanced**

Minimise the standard deviation of the occupancy percentage of fire brigade i in order to obtain balanced sectors

$$\min \sqrt{\frac{\sum_{i=1}^M (k_i - \bar{k})^2}{N}}$$

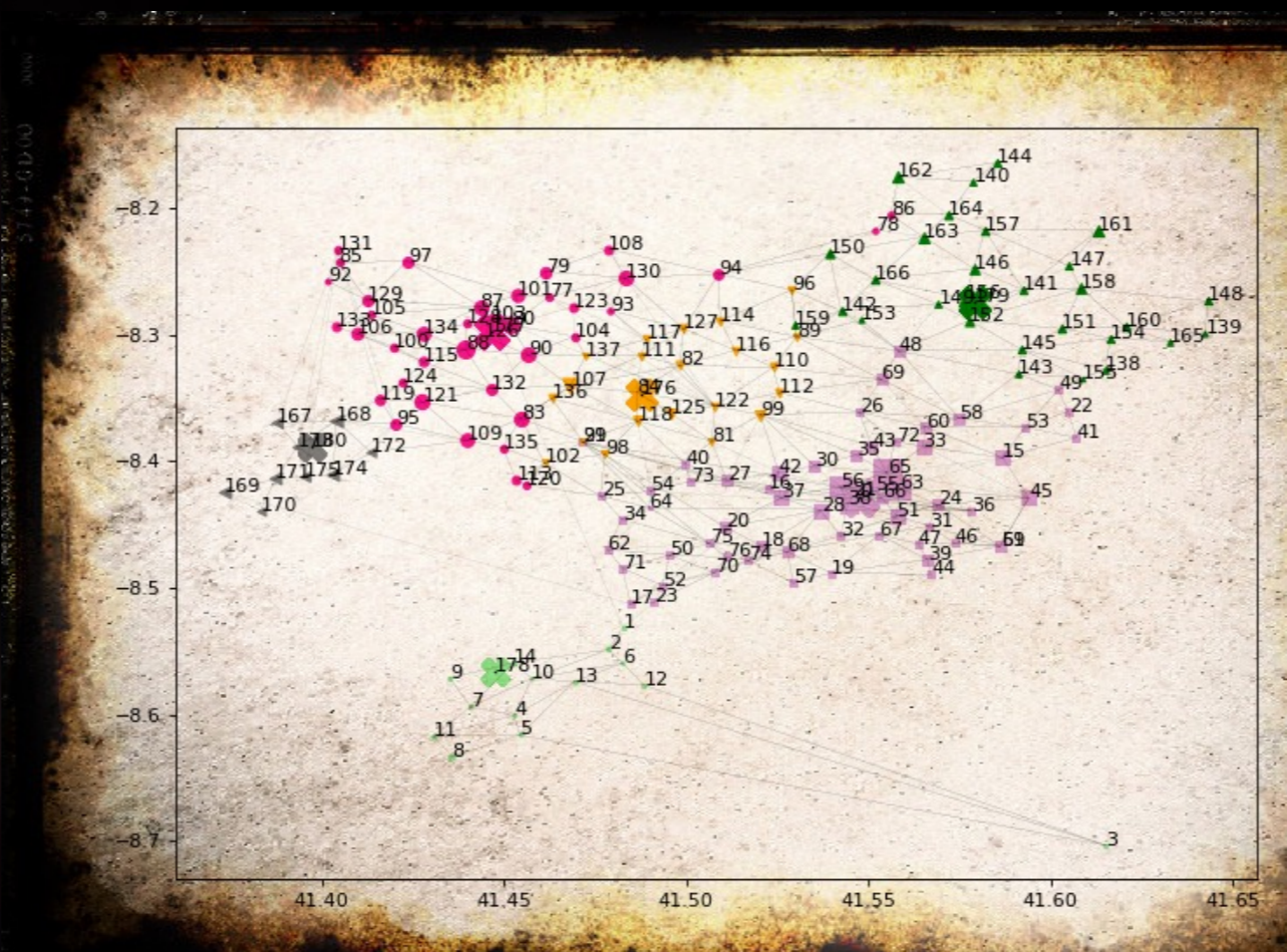
where $k_i = \frac{\sum_{j=1}^N s_{ij}}{c_i}$ is the percentage of used capacity of fire brigade $i \in \{1, \dots, M\}$, \bar{k} is the average of k_i and s_{ij} is the demand of the subregion j , if j is assigned to the fire brigade i and zero otherwise.

- **Compact**

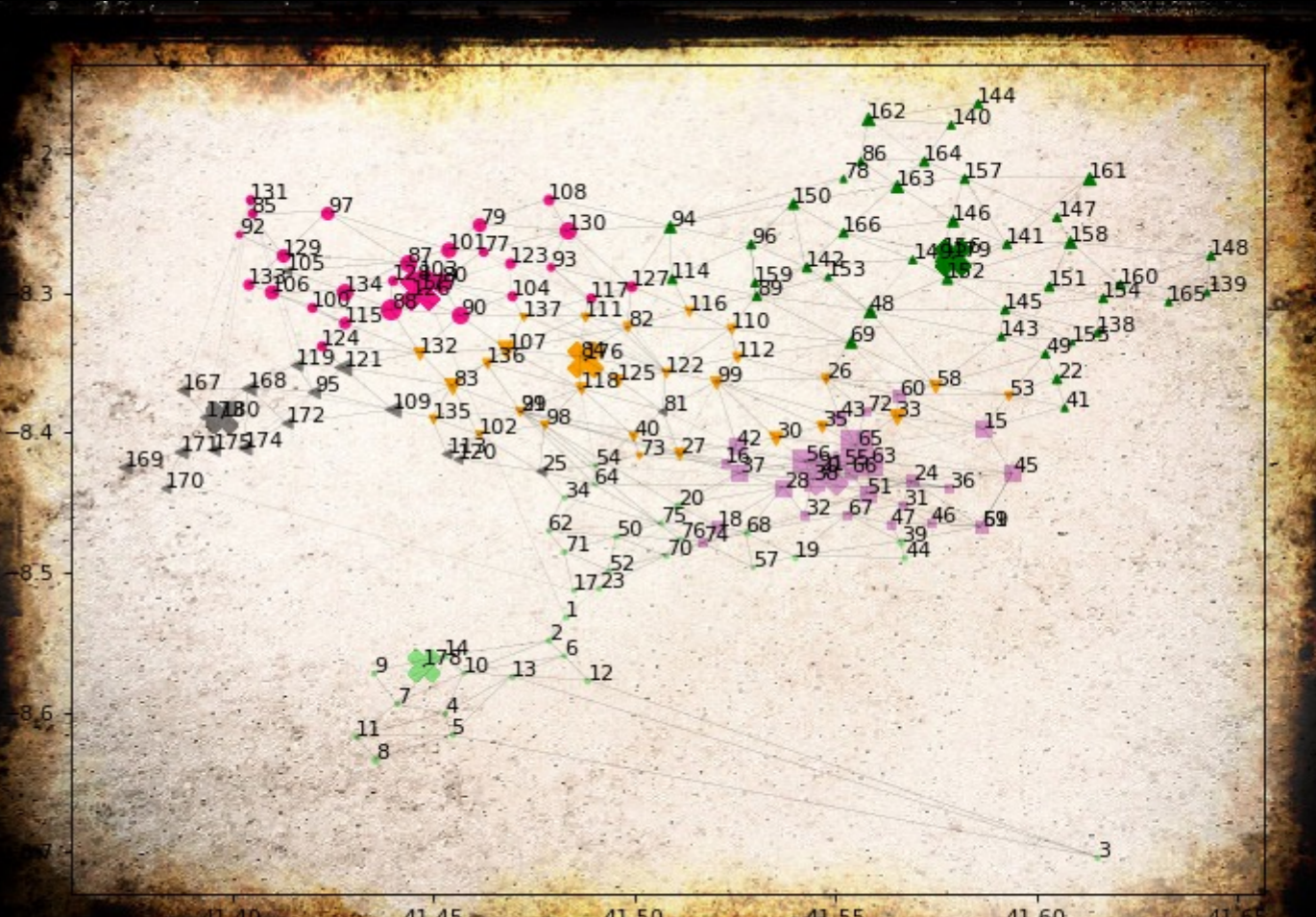
Minimise the distance between fire brigades and subregions, weighted by the demand of each subregion, in order to obtain compact sectors

$$\min \sum_{i=1}^M \sum_{j=1}^N d_{ij}s_j$$

where d_{ij} is the distance between brigade $i \in \{1, \dots, M\}$ and subregion $j \in \{1, \dots, N\}$.



Current sectorization has 0.284 of equilibrium and 0.035 of compactness



The optimal resectorization has 0.053 of equilibrium and 0.037 of compactness with a similarity of 70.3%

Contributions:

**OPTIMISE SECTORIZATION AND
MINIMISE RESCUE TIME**

Work developed by the team of FCT Project StoSS, with precious collaboration of fire brigades in the north of Portugal region.