Logotipo

Descripción generada automáticamente

**Logistics Project Report**

Facility Location Problem

“Ambulance location”

|  |  |
| --- | --- |
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# Problem description

The aim of this projects is to solve a location problem for ambulances, so that the emergency services coordinator can maximize the number of residents covered within four minutes in emergency situations. Due to budget restrictions, the coordinator can only set 2 ambulances in all the five regions. The possible area of location is divided in five regions and the average time required to travel from one region to another is given in the following Table 1.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | | **To region** | | | | |
| **1** | **2** | **3** | **4** | **5** |
| **From region** | **1** | 0 | 4 | 6 | 3 | 2 |
| **2** | 4 | 0 | 2 | 3 | 6 |
| **3** | 6 | 2 | 0 | 5 | 3 |
| **4** | 3 | 3 | 5 | 0 | 7 |
| **5** | 2 | 6 | 3 | 7 | 0 |

Table . Average travel time between regions

Also, the number of residents in each region is specified in the following Table 2.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Population** | | | | |
| **1** | **2** | **3** | **4** | **5** |
| 4.500 | 6.500 | 2.800 | 5.200 | 4.300 |

Table . Population of each region

# Mathematical formulation

In order to solve this problem, first it was necessary to identify to which kind of problem we are dealing. By reading the problem is easy to identify two key comments. The first, is to locate the ambulances in a possible region and, second, there is an upper limit on the number of facilities that can be opened (budget constraints). With this, we can point that the problem corresponds to a Maximal Covering Location Model (MCLP).

## Integer linear programming model

Define the input data as follows:

Next, the following are the decision variables:

The formal ILP model is as follows:

Where each of the formulas has the following meaning:

① The objective function denotes that we are looking to maximize the population covered

② Constraint that limits the quantity of ambulances to place

③ Covering constraint

④ Binary variables

When applying the ILP model to the problem posed, it is important to clarify the values that the variable takes in this case:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Population covered** | | | | | |
| **1** | **2** | **3** | **4** | **5** | **Total** |
|  | 4.500 | 6.500 |  | 5.200 | 4.300 | **20.500** |
|  | 4.500 | 6.500 | 2.800 | 5.200 |  | **19.000** |
|  |  | 6.500 | 2.800 |  | 4.300 | **13.600** |
|  | 4.500 | 6.500 |  | 5.200 |  | **16.200** |
|  | 4.500 |  | 2.800 |  | 4.300 | **11.600** |

Table 3. Total population covered if facility is opened in a certain region

With this, the ILP model for this problem is the following:

# CPLEX results

After the AMPL implementation (see annex) the values obtained using CPLEX Solver for each function is the following:

* Regions where the 2 ambulances will be set:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Facilities to open** | | | | |
| **1** | **2** | **3** | **4** | **5** |
| 1 | 1 | 0 | 0 | 0 |

Table . Ambulance set by region

## 2 ambulances vs. 1 ambulance

# Annex

## Mod file

Texto, Carta

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## Dat file

Tabla

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