

The six neighbouring towns, A, B, C, D, E, F, own social centers and have decided to organize their health care services jointly in order to reduce costs. Consider the travel times between these six neighbouring towns, A, B, C, D, E, F, shown in the table below:

	A	B	C	D	E	F
A	0	15	25	35	35	25
B	15	0	30	40	25	15
C	25	30	0	20	30	25
D	35	40	20	0	20	30
E	35	25	35	20	0	19
F	25	15	25	30	19	0

## 1 Locating health services

The committee planning the creation of health services wants to decide on the location of the health services to be installed in some of the social centers. For reasons of mobility and safety, the social center in each city must be within 20 minutes of at least one health service.

Help decide where the health services should be located, bearing in mind that the aim is to minimize the number of social health care services, as the cost of establishing them is too high.

1. Identify and model the problem in integer linear programming. Carefully define all the variables and explain all the constraints.
2. Describe a method and use it to obtain a feasible solution to the problem.
3. Using software that solves integer linear programming problems, obtain the optimal location plan and describe the solution. Attach the code used to solve the problem.
4. Compare the feasible solution obtained in 2 with the solution obtained in 3. Provide a brief report that can help the committee make a decision.
5. The committee planning the creation of health care services wants to assess the impact of each of the following decisions when considered separately:

**case 1:** There should be a health care service in either city E or city F, but not both.

**case 2:** If there is no health care service in city F, then there must be one in cities A or C.

**case 3:** There must be at least 2 health care services in cities A, C, E, F.

Model each new constraint and indicate the solution in each case. For each case, give a short report that can help the committee to assess the impact of each case.

## 2 Visiting social centers

Often a medical team will visit all 6 social centers (in one day). Since the team wants to take the shorter total travel time, help them decide which route to take.

1. Identify and model the new problem in integer linear programming. Carefully define all the variables and explain all the constraints.
2. Obtain a relaxation bound. Describe the relaxation and comment the solution obtained.
3. Use Solver (evolutionary method) to obtain a solution, comment on the results compared with the value achieved in 2.
4. If possible, describe and apply a method that allows you to improve the solution obtained in 3. Comment on what you have obtained.

Write a report (maximum six pages) with your answers. The report must be accurate, clear and simple.