Optimization of inspection routes

submitted by The Co-operators

Each year ten company inspectors must inspect a certain number of buildings. The list of these buildings includes 10,000 items but it is not possible to inspect them all. At the time being approximately 3000 buildings are inspected each year but the company would like to increase this number, while taking into account the priorities of buildings and cost constraints (where the costs depend, among other things, upon the location of inspectors). A building priority is represented by a number comprised between 0 and 10, where 10 is the highest priority. The inspection routes currently used by the company assign the largest weight to the buildings with the highest priority. The company, however, is considering another method of designing routes and envisions an objective function that is the sum of "priorities raised to the power 1.5." In this case the inspection of two buildings of priority 7 would be preferred to the inspection of a single building of priority 10 (say). Other functions could also be considered.

The company's budget for inspecting buildings is denoted by Y. Therefore the total cost of the inspectors' salaries, travel, and lodging must be at most Y. Furthermore an inspector works between 7 and 9 hours per day, 5 days a week. An inspector may not work more than 200 days in any given year and the inspection of some of the buildings is compulsory. As far as possible the inspector will go home each evening in order to minimize his lodging costs and maximize his comfort. When that is not possible, he will stay at a hotel and inspect the buildings that are located near the hotel. Here are the data used to compute the costs.

- The travel cost per kilometer is $0.45.
- The hourly salary of an inspector is $40.
- A night at the hotel costs $200.

To evaluate a route cost one must know the coordinates of inspectors (i.e., those of their homes) and the coordinates of the buildings. The company has the following information:

- the latitude, longitude, inspection time (in hours), and compulsory inspection indicator ("yes" or "no") for each of the 10,000 buildings; and
- the home coordinates (latitude and longitude) of each of the ten inspectors.

Hence the problem consists of maximizing an objective function depending upon the building priorities, under the constraints described above. In this fashion the company is hoping to construct routes that include more buildings than the current routes.