Société de Calcul Mathématique, S. A.
Algorithmes et Optimisation

Examples of application of the Robust Mathematical Modeling concepts

Example 2 : a used-water management system

The ambition of the RMM program is to handle uncertainties, which occur quite naturally in any scientific project.

The project we now describe comes from a contract with Veolia Environnement, West Region, in 2004-2005. It concerns the system of management for used (polluted) waters in a large city, West of France.

Used waters, before they go to the ocean, are treated using chemical and biological procedures, in filtration stations. The whole system belongs to the City, and Veolia is only in charge of exploiting it. So Veolia cannot decide, for instance, about new equipments. But, on the other hand, when something goes wrong (for instance, when a pollution appears), then everyone blames Veolia, who is in charge of the exploitation.

In 2004, Veolia asked us : how such a used water system should be organized, ten years from now ? What modifications, improvements, should be made, and how to decide them ?

We were first given three months for a preliminary study, and then a full year for complete study. At the end, we presented our conclusions to Veolia, who organized a meeting for us with the Authorities of the City.

Mathematically speaking, such a contract is quite hard, because one does not see what are the parameters to play with. There are many possible ways for optimization, and none of them is satisfactory. Moreover, the data are quite coarse, and, within ten years, many changes may happen.

Our first line of thought was to define what we called a "quality contract". The problem, with used waters, comes from heavy rain : in such a case, the filtering stations do not work correctly, and part of the pollution goes through. The capacity of treatment of the stations is known, so we scanned the rainfall, on that city, for a whole year, in order to see how often the capacity was overcome and how much. This scanning was done on a daily basis.

The result of this work was a statement of the following form ("quality contract") : with the existing equipment, we can ensure that the stations will work correctly if the rain does not exceed 3 mm/hour during 3 consecutive hours. If the rain exceeds that amount, the present equipment will be insufficient (and we made that quantitative : what equipment for what amount of rain). This was very satisfactory, at the intellectual level, because from that we could see the cases where the system should work and the cases where the system could not work : these data were communicated to the Authorities.

Then we investigated the construction of basins : it can be appropriate to build basins, and therefore keep the rain for some time, for later treatment. This allows a better use of the existing stations : building a basin is much cheaper than building a station. We computed the volume needed for the basins, within a prescribed probability ; we found a proper volume : smaller would result in very frequent flooding of the stations, larger would be useless.

Then we showed that interconnections between the stations and the basins was necessary, in order to ensure quality of service, would something break down (the duration of repair is known on average).

Finally, we showed how to control the required quality : where to put sensors, both for everyday use and in order to detect an accidental pollution, and with what frequency these sensors should operate.

Here, we see a very good application of the RMM ideas : to try to define and compute a very precise waste-water system would be totally hopeless and absurd ; the data are rough and the objectives were not properly defined. Our work (and we can regard this as our most difficult contract) was to define the objectives in such a way that they would make concrete sense, with the existing data, within the budget, within political constraints and so on.