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Algorithmes et Optimisation

Examples of application of the Robust Mathematical Modeling concepts

Example 3 : Importations of gas

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

The project we now describe was requested to us by the French "Direction Générale de l'Energie et des Matières Premières" (Ministry of Finances), in 2006. It deals with this simple question : is there a risk of insufficient gas supply in France ? We speak about natural gas ; France used to produce some amount, but our production is almost finished, so we have to import most of our needs. We have four main suppliers : Algeria, North Sea, Netherlands and Russia, and we buy the rest on open markets.

If the importations are insufficient at a given time, three remedies can be sought :

- Import more (from the same producers, or from other producers) ;
- Increase the stocks ;
- Reduce the demand (Gaz de France has a convention with some big industrial companies : they accept to reduce their consumption on given days, with early warning, but they pay less).

First, we tried to see if the consumption depends on the temperature, and how. Indeed it does, but not as a simple law (certainly not linear). We had daily data only for 19 months, but even if we had had earlier data, it would not help, because habits change very quickly (consumption increases). So, using these 600 days, we built conditional probability laws : when the temperature is in a certain interval (for instance 10°C to 10.5°C), what is the distribution of consumption ?

Then we used a long history of temperature (100 years) in order to build a probability law of temperature. Using both together, we could build a probability law of consumption for a given day : what is the probability of a consumption between 1 and 1.1 TWh for March 7th, for instance.

We did the same for the supplies : for each producer, we determined a probability law per day.

The stocks (which are compulsory by law) were supposed to be empty end of March (when winter finishes). So, the distribution law of the stock, for each day, can be computed using the distribution law of all supplies, for previous days, and the distribution law of the consumption, for previous days also.

Finally, our conclusion from this analysis was that the stocks were not completely sufficient : there was a significant probability that, at some time of the year, the demand would exceed the existing capabilities. But the global import, summed over a year, was sufficient, so the problem came from the stocks, not from the supplies.

Here, the RMM tools allowed us to worked with probability laws. This is the only acceptable tool since, for instance, any kind of adjustment would provide poor results. The data depend on too many parameters : trying to understand all of them and trying to figure out precise dependence laws is totally hopeless and would be useless.