Forum :

*Ingrédients santé beauté bien-être*

Application des méthodes probabilistes
pour la reconstitution de données manquantes
dans les études cliniques

Vannes, décembre 2007
Les méthodes probabilistes présentées ici ont initialement été introduites en 2003-2004 dans le cadre d'un contrat avec Framatome-ANP.


Elles ont été utilisées en 2006-2007 dans le cadre de contrats avec Veolia Environnement, Région Ouest, avec l'Agence Européenne de l'Environnement, et avec le CEA.
Cosmetology as a science about beauty

The main needs and interests of cosmetology:

Very often the scientific approaches connected with health, beauty and well-being, deal with quantitative characteristics, given by measurements. It can be, for example, blood pressure, elasticity of skin, concentration of some molecules and so on.

The use of available measurements:

When the measurements are made, one tries to establish some correlation between the quantitative results and people’s reactions. For example: what is the efficiency of some cream depending on the age and how long it has been used?

The difficulties usually met:

The main problems here relate to the number of the measurements and their meaning.

- Very often, the number of data is insufficient. The reasons can be: high cost of the experiment, the data were lost due to some accident, technical impossibility of realization of a given test and so on.

- Sometimes it is hard to draw some conclusion from the present data due to their lack of pertinence. For instance, is it possible to apply data obtained for young people to older ones?
Possible solutions of the problem

We want to develop robust mathematical methods which will help increase the amount of information derived from the existing measurements. This includes a possible reconstruction of missing data.

Two different mathematical approaches can be applied:

**Deterministic methods**

Usually, such methods use artificial assumptions. For example, they suppose that some phenomenon has a linear behavior and reconstructs it with a linear trend. But nature is never linear, and such methods rarely give satisfaction in practice.

**Probabilistic methods**

These methods do not give precise answers, but the results are presented under a probabilistic form. This is much more satisfactory in practice, because a result (especially in human situations) can never be asserted with full precision: not all people react the same way under the same treatment. This variability is taken into account by probabilistic methods.

We present below the use of the most recent method we built, the “Experimental Probabilistic Hypersurface” (EPH).
**Example of typical problems in cosmetology**

We give here a simple example which presents well the general ideas behind our probabilistic method. It concerns the analysis of the efficiency of a cream: « *Traitement en dermato-cosmétologie sur deux groupes de femmes (32-36 et 46-52 ans)* ».

Only two groups were treated, and we have the results of an experiment for 15 women, given below: for each patient, age, duration of the treatment and efficiency (scale: from 0 to 10). What can we deduce from this small sample?

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age</th>
<th>Duration of treatment (days)</th>
<th>Efficiency (0 - 10)</th>
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</table>
**Answers brought by probabilistic methods**

From the small panel described above, the probabilistic methods bring full answers to the following questions:

1) What can we expect as an efficiency of the cream for other women, for instance 40 years old? For such women, no test was made (see answer below).

2) What efficiency can we expect with another duration of treatment, for instance 23 days? (see answer below).

3) What is the optimal age and duration of treatment in order to get the best efficiency?

4) What parameters have the highest influence upon the result of the treatment? For instance, does it depend most upon the age? upon duration? In practice, the number of parameters is usually quite large (50, 60, or above), and our methods can handle such situations.
Example of results

The graphs below represent the probability law of efficiency of the cream for woman 40 years old and duration of the treatment 10 days and 23 days:

Age : 40 years old ; duration : 10 days

Age : 40 years old ; duration : 23 days
Interpretation of the results

We see on these graphs that the probability of efficiency for woman 40 years old is quite different for various durations:

For example, if the treatment lasts 10 days, then the probability to get high efficiency (for instance $\geq 7$) is 0.51. If the treatment continues for 23 days, then the probability of having high efficiency increases up to 0.8.

Also, we found that a further increment of duration does not give significant amelioration of efficiency comparing with the one obtained for 23 days.

Decision making: though no women of age 40 was included in the panel, we see that we should organize for them a treatment about 23 days.

The same kind of calculation can be performed for other ages which were not being tested.