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Opinion
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Biometry to Incorporate Analysis of Behaviour of Living Organism

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Opinion

Biometry to incorporate analysis of behaviour of living organisms. Usual definitions of Biometry as dealing with mathematical and statistical analysis of biological observations or phenomena do not exclude analyses relating to behaviour of living organisms and changes in this behaviour caused by changes in their environment - instant or remote. Aspects of behaviour are not all manifest, and observations on latent aspects or dimensions are only proxies or surrogates .Measurements on behaviour and, that way, psychological measurements are not - strictly speaking - biological measurements, though such measurements do relate to living organisms. Thus Biometry need not cross over to occupy the space traditionally belonging to Psychometry. While, Psychometry deals more with latent variables, Biometry is concerned more with manifest variables, though some of these variables may not admit of unique or precise measurements. Of course, there have been recent investigations on genetic aspects of human as well as animal behaviour and genetic measurements are justifiably included within the ambit of Biometry.

A common problem in analyzing biological phenomena as revealed through manifest and latent variables is the problem of reducing multiple variables into a smaller subset that reflects the underlying phenomenon. Sometimes, the need is to develop a single unit-free index that varies within two pre-specified limits and carries substantial information about the phenomenon. And these variables are generally expressed in different units, are related among themselves according to a pattern represented by the inter-correlation matrix and carry different weights. This problem - call it a dimension reduction problem, if you like - is faced in many different areas of investigation and not just in Biometry.

One approach could be to consider each variable separately, and transform it to a dimensionless measure. Subsequently, these transformed variables could be combined by taking a weighted average where the weights are exogenously specified by domain experts as indicative of the relative importance of any observed variable in making a given form of inference about the underlying phenomenon. The transforms can be so worked out that the weighted average has a specified range of variation in values. To make the transforms unit-free, one possibility is to consider the deviation of the observed value of a variable from some desired or reference value and then to divide by the range between the permissible extreme values of the variable. One obvious limitation of this approach is that it ignores information about inter-relations among the variables. The other centres round the arbitrariness of the weights assigned to the variables and the non-uniqueness of the transform.

Assignment of weights to different variables to indicate the value of information revealed by data on each of the variables can be sometimes decided endogenously in terms of the data themselves. One may argue that coefficients of principal components, which are purely data-based, can be looked upon in some sense as the weights. However, These combining coefficients are not to be treated as weights directly. The other option to develop data-based weights is analogous to Data Envelopment Analysis (DEA) used by econometricians to compare relative efficiencies of several decisions - making units which use or deploy multiple inputs to arrive at multiple outputs. The problem here is to determine weights to be associated with different inputs and outputs in such a way that the ration between the weighted aggregate of outputs and the weighted aggregate of inputs in maximized.

Let us consider the relatively common situation in which different biological measurements are taken on units in the treatment group and different facets of potential incidence of some disease or abnormal behaviour are observed for each unit. Here a multivariate regression analysis with the facets as dependent variables and biological measurements as the explanatory variables could be worked out. The regression co-efficient could indicate weights of different biological measurements as explaining or predicting each of the different facets separately considered.

DEA models and tools could have been used provided. We deal with a situation involving several inputs like stimuli

administered to units under observation producing several responses by each unit and, more importantly, we could identify some objective function of the input and output variables which can reflect on the principles governing the stimulus-response relations. Dealing with multiple responses produced by levels of a single input stimulus like dose of a biological preparation in a bio-assay illustrates a simpler situation that also evades a unique solution. As expected, DEA involves repeat applications of linear programming for the purpose of maximizing a linear objective function (after suitable transformation of the original problem with a ratio as the objective function) subject to certain constraints.

The quondary that continues to embarass research workers in their bid to assign weights to multiple measurements is the question: should the choice of weights be left to domain experts or should we develop weights from the measurements as obtained in our study? A clever answer would be: combine both. And in the first case, one is well-advised to involve more than one expert and to ascertain the extent to which different experts agree among themselves about the relative importance of the different variables. Going by ranks to indicate relative importance (rank one implying the 'most important'), one can use Kendall's coefficient of concordance and use Friedman's Chi-square test for significance of its observed value. If a substantial concordance can be established among the domain experts, average ranks can be well taken as weights.

Research will always throw up questions and will provide answers on some occasions. Hence the need for continuing research - not just on many diverse phenomena which have now come under the perceptual world, but even on the same phenomenon to get a better and deeper insight .

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