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A new technique based on the *Law of Comparative Judgment* for quality-related problems

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Abstract

A common problem in the field of Quality Engineering/Management concerns the fusion of multiple *subjective* judgments, expressed by a group of individuals, into a collective judgment [1]; possible examples are: (i) judgments by customers on the importance of a set of product requirements, (ii) judgments by reliability and maintenance engineers on the severity of a set of (presumed) process failures, (iii) perceptions by designers and marketing experts on the brand image of several competing products, etc..
At the risk of oversimplifying, the problem of interest includes the following features:

- A collection of *objects* to be compared on the basis of the degree of some *attribute*, i.e., the mental response that they evoke;
- A set of *judges* or *respondents* that individually express their *subjective* judgments (i.e., problem *input*) on the objects, to be fused into a single *collective judgment* (i.e., problem *output*), usually expressed in the form of a *scaling* (i.e., assignment of numbers to the objects, according to a conventional rule/method).

The scientific literature encompasses a plurality of fusion methods, such as the equal-appearing interval scaling (EAI), the Yager's algorithm, or the Rasch model [2]. These methods differ from each other for (at least) three aspects:

1. The *response mode* for collecting the (input) respondent judgments, e.g., expressed in the form of preference orderings, paired-comparison relationships, ratings, etc.;
2. the underlying *rationale* of the method, e.g., heuristic, mathematical/statistical, or fuzzy models;

3. the type of (output) *collective judgment*, e.g., expressed in the form of ranking or ordinal/interval/ratio scaling.

The output is often treated as if it were defined on a *ratio* scale, even when it actually is not; e.g., a ranking or ordinal scaling may be improperly promoted to an interval or ratio scaling. This kind of scale promotion is potentially dangerous, as it can lead to significant distortions [3].

The goal of this contribution is to develop a new technique based on the Thurstone's *Law of Comparative Judgment* (LCJ) and to utilize it as a fusion method for the problem of interest [4]; although the LCJ is consolidated in the scientific literature, it is actually underused in the field of Quality Engineering/Management [5]. The proposed technique will be based on the combination of the canonical LCJ model with an *ad hoc* response mode based on preference orderings. Apart from the "regular" objects, these orderings will also include two "dummy" or "anchor" objects, to univocally identify the zero and the maximum-imaginable value of the output scale. It will be shown that, in this way, the scale could (reasonably) be considered as a ratio one.

Apart from being relatively practical and respondent-friendly, the proposed method allows to obtain a reasonable and powerful scaling. Additionally, it is applicable to a wide variety of practical contexts, such as problems in which (i) the (input) preference orderings may include omissions and/or incomparabilities between some objects, and/or (ii) respondents are not necessarily equally important.

The description is supported by a real-life example that concerns the competitive benchmarking of several products, based on a specific attribute (i.e., their simplicity of use).

References

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