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Descriptive analysis of responses to items in questionnaires. Why not using a fuzzy rating scale?☆



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ABSTRACT

In evaluating aspects like quality perception, satisfaction or attitude which are intrinsically imprecise, the fuzzy rating scale has been introduced as a psychometric tool that allows evaluators to give flexible and quite accurate, albeit non numerical, ratings. The fuzzy rating scale integrates the skills associated with the visual analogue scale, because of the total freedom in assessing ratings, with the ability of fuzzy linguistic variables to capture the natural imprecision in evaluating such aspects.

Thanks to a recent methodology, the descriptive analysis of the responses to a fuzzy rating scale-based questionnaire can be now carried out. This paper aims to illustrate such an analysis through a real-life example, as well as to show that statistical conclusions can often be rather different from the conclusions one could get from either Likert scale-based responses or their fuzzy linguistic encoding. This difference encourages the use of the fuzzy rating scale when statistical conclusions are important, similarly to the use of exact real-valued data instead of grouping them.

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1. Introduction

In rating many characteristics or attributes that cannot be directly measured (like perceived quality, satisfaction, perception, attitude...), different scales have been considered. The best known scales in this setting (see, for instance, Yuen [66]) are the discrete ones, which consist of choosing the most appropriate 'values' within a class according to the rater judgment (like Likert-type scales) and the continuous visual analogue scale, whose aim is to specify an exact level of agreement to a statement or property by choosing a single point along a line between two end-points (i.e., along a compact interval).

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When *Likert-type scale* data are analyzed for statistical purposes, they are either treated as categorical ones, so that techniques to analyze them are quite limited, or numerically encoded by means of consecutive integer numbers, which enlarges to some extent the number of procedures to be applied. The main positive features in connection with the use of Likert-type scales are that

- ▲ surveys/questionnaires based on them are easy-to-conduct, and they require neither a demanding training nor a special framework,
- ▲ labels for the given ‘values’ are expressed in terms that properly fit the intrinsic imprecision of the considered characteristics or attributes.

Nevertheless, several weaknesses have been highlighted in the literature on this type of scale (see, for instance, Jamieson [31], Carifio and Perla [9], Calcagnì and Lombardi [8]), namely,

- ▼ the number of possible ‘values’ to choose among is small, so the variability, diversity and subjectivity associated with an accurate rating is usually lost, and the choice of the most appropriate ‘value’ is not necessarily a simple task (raters often prefer to have the opportunity of choosing in between two ‘values’);
- ▼ when ‘values’ are encoded by their relative position in accordance with a certain ranking, differences between codes cannot be interpreted as differences in their magnitude, so only the statistical conclusions addressed to categorical or ordinal data become really reliable and relevant information can be lost.

Several studies (see, for instance, Reips and Funke [46], and Treiblmaier and Filzmoser [60]) have pointed out that the *visual analogue scale* provides researchers with many advantages in contrast to discrete scales. Thus, one can benefit from a metric setting as well as from the fact that a much wider set of statistical methods can be applied to analyze the data coming from this rating. As for the Likert scales, one can find some *pros* and *cons*.

Among the *pros*, one can remark that

- ▲ the choice is to be made within a continuum, so the variability, diversity and subjectivity is ensured,
- ▲ statistical conclusions are reliable and no relevant information is generally lost.

Among the *cons*, one can mention that

- ▼ the choice of the most appropriate point is not a simple task, and it does not seem realistic to demand as much accuracy in connection with such an intrinsically imprecise context;
- ▼ surveys/questionnaires based on the visual analogue scale require a special framework and either a paper-and-pencil or a computer/web-based form to be filled.

Benoit [3] (see also Benoit and Foulloy [4]) asserts that, from a measurement point of view, the fuzzy scale “establishes a link between strongly defined measurements... and weakly defined measurements”. In this respect, Calcagnì and Lombardi [8] (see also de la Rosa de Sáa *et al.* [14,15]) indicate that fuzzy scales have been applied to overcome the limitations of standard scales by modeling the imprecision of human rating evaluations. Two approaches should be mainly distinguished in applying fuzzy scales, namely,

- the *fuzzy linguistic scales*, which are frequently considered for different goals as an *a posteriori* tool to encode data from a discrete (often a Likert) scale by means of fuzzy numbers (see, for instance, Zadeh [67], Tong and Bonissone [59], Pedrycz [42], Herrera *et al.* [26, 27], Lalla *et al.* [32], and also Li [33], Akdag *et al.* [1], Estrella *et al.* [18], Massanet *et al.* [39], Tejada-Lorente *et al.* [57,58], Villacorta *et al.* [62], Wang *et al.* [63], García-Galán *et al.* [19], Liu *et al.* [34] and Tavana [56], about some very recent developments and applications in connection with perceived quality, satisfaction, etc.);
- the *fuzzy rating scale*, which is considered as an *a priori* tool to directly assess fuzzy values and integrating the continuous nature and free assessment of the visual analogue scales with the ability to cope with imprecision of the fuzzy linguistic ones; this scale has been introduced by Hesketh *et al.* [30] (see also, among others, Hesketh and Hesketh [29], Matsui and Takeya [40], Takemura [53–55], Yamashita [65], Hesketh *et al.* [28] and de la Rosa de Sáa *et al.* [14] for some developments and applications).

The Likert, visual analogue and fuzzy linguistic scales have been commonly involved in research with questionnaires. The fuzzy rating scale has been applied too, but only occasionally in spite of the clear advantages associated with its use that will be detailed in the next section.

As we know, the success of a questionnaire method based on a certain scale depends on the reliability and easy-to-handle use of such a scale. Reasons why the fuzzy rating scale is not so popular yet can probably be found in the following critical requirements:

- ▽ a certain framework is needed to conduct a fuzzy rating scale-based questionnaire (e.g., it cannot be properly conducted by phone, on the street, etc.);
- ▽ respondents need a certain training to answer a fuzzy rating scale-based questionnaire;
- ▽ a special statistical methodology is needed to analyze responses from a fuzzy rating scale-based questionnaire.

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