

OPINION

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Concerning the award of the educational and scientific degree “Doctor” based on the submitted PhD thesis:

„Comparative Scanning Method (cSM) capabilities in analysis, visualization, and psychological interpretation of experimental “Preferential choice” data”

1. Scientific significance of the research problem considered.

The topic of the presented thesis is in line with modern research and explores the possibilities of a method proposed by the author for the analysis of evaluations of the "preferential forced choice" type in various fields – psychophysics, cognitive psychology, and personality psychology. The proposed method is similar to the well-known and widely applied method of multidimensional scaling and unfolding, which has been developed since the middle of the last century until now. This type of method is widely used in data processing and visualization based on similarity and preference evaluation and is used in both fundamental and applied research, e.g., in marketing research.

2. Justification of the goals and the objectives in the dissertation.

The main goal of the dissertation is to present the so-called comparative scanning method (cSM) and the analysis of its capabilities for various types of data obtained by the pairwise preference forced choice method. The realization of this goal is logically related to the objectives of the thesis, namely the development, updating and testing of accessible software that allows the design and realization of experiments and visualization and analysis of the obtained results.

One of the most important objectives is to conduct a series of experiments from various fields in psychology, which provide information about the applicability and validity of the proposed method. In the implementation of this task, the capabilities of the specially developed software are also shown.

One of the further formulated goals is the combination of idiographic and nomothetic descriptions in the context of cSM, which in the experiments presented in the dissertation involves the analysis of the ideal points of individual participants and experimental groups. This approach has been widely applied to the use of the MDS and unfolding method, and the application of cSM for this type of analysis is fully justified.

Another objective of the thesis is to connect cSM with the so-called “associative interaction theoretical model”, put forward by the author with the aim to “derive” the dependence of the preference probability assuming a hypothetical associative interaction in psychological stimulus space, and not just choose it so that some error function is minimized when comparing with empirical data.

One criticism concerning the formulation of the goals and objectives of the thesis is the mentioning of the results and the contributions which creates the impression that they are assumed before being demonstrated later in the thesis. Similarly, this includes the use of concepts which are not yet defined in the first sections of the thesis like “referent stimulus”, kinds of distributions of reference stimuli (ideal points), direct Likert scale evaluation using indirect determination of referent stimuli, etc.

3. How appropriate is the chosen research methodology for the goals and objectives of the thesis.

The chosen methodology is appropriate for the chosen goals.

4. Scientific and applied scientific contributions of the dissertation (description and evaluation)

The thesis formulates a new method for processing and visualization of preference choice data based on the estimation of the preference probability by scanning a previously constructed fixed attribute space with a small number of feature dimensions.

In contrast to the well-established MDS method, the proposed method assumes a fixed two-dimensional or three-dimensional Euclidean stimulus space, assuming that it is adequate to reflect the preference psychological space of the person under study. For each feature dimension, two stimuli are chosen (above detection threshold), leading to a choice between all the combinations of 4 stimuli for two-dimensional space and 8 stimuli for three-dimensional space, respectively, without repetition.

With empirical data provided by the method of preference forced choice, using a rule to express a probability of preference through the distances between the stimuli and the so-called reference stimulus for the examined person, for each point of the stimulus space (scanning process) the so-called "matching factor" is calculated. The matching factor is the sum of the absolute values of the difference between the empirically estimated probabilities and the theoretical probabilities.

The calculation of theoretical probabilities is based on a rule involving the distances between a point and the positions of the pairs of stimuli in the stimulus space based on the so-called "Theoretical model of associative interactions" proposed by the author. One criticism about the presentation of this model in the thesis, in addition to being very brief, is the lack of a deeper justification of the particular type of the so-called "associative interaction" and its dependence on the size of the psychological space.

For instance, in Appendix 1, the conclusion is made that in a one-dimensional space the associative interaction does not depend on distance "because the distribution of the front is a point" which needs clarification. The way the distances used to calculate the preference probabilities are defined is also not so clear from the description given in fig. 73 (Appendix 1). It demonstrates how the associative interactions allow to determine a point on the line segment between the two stimuli which defines the two distances.

Thus, there are two quantities accounting for preference or similarity – associative interaction and the position of the stimuli in the psychological space. The connection between these two quantities must be further clarified. One question that could be asked concerns the basis of the assumption that the dimension of the constructed stimulus space and the psychological space are the same, especially if there is a reference stimulus, expected to be defined in the full feature space. Related to it is the question what the reference stimulus is for something unseen before.

The approach put forward in the thesis seems innovative, but adequate literature review and discussion allowing to assess its effectiveness and importance compared to other existing methods is missing. The author stands on the position of a logically sound framework and doesn't offer a deeper analysis of the differences with other approaches and what the advantages of cSM compared to them are.

The specific choice of space with a limited number of attributes reminds the so-called „conjoint analysis" aimed at identifying the combination of features which can explain best the preference of one stimulus to another. This method is used in marketing studies and departs from the features of interest for the producers and the preferences of the customers.

This analysis, which is an alternative to the MDS method is focused on a small number of attributes but includes an analysis of the attribute levels, which are important for the customers' choice and allows for the development of a model with the weighted importance of every attribute level. In this analysis, the

importance to include the right level of the features is stressed (e.g., intermediate level together with low and high level; the user may prefer the intermediate level to the low and high levels but be indifferent between the low and high levels). It is interesting to investigate the link between that approach and the cSM.

In my opinion the main contribution of the thesis is the formulation of a new, and maybe simpler and more applicable approach (e.g., as stressed in the thesis, applicable when time is scarce or when participants have some mental impairment), whose applicability in practice is thoroughly studied empirically in a variety of experimental situations from psychophysics, cognitive psychology, and personality psychology. The proper evaluation of the contribution of the approach to the field would benefit from the direct comparison with alternative approaches which is missing in the thesis but I would recommend to be carried out in the near future.

Another methodological contribution is the design and implementation of a specialized software which allows not only the processing, visualization, and analysis of empirical data but supports the whole process of designing and conducting experiments. The fact that this instrument is available to interested researchers in Bulgaria is very important because it will lead to the improvement of the software itself but also to the improvement of the whole approach. Again, the presentation of the software would have benefited from a comparison to the resources available in R and other statistical packages. In any case the big efforts invested in its development and making it available to researchers is an important methodological contribution.

The study of the preferences of participants in experimental tasks from various psychological domains following the rules for conducting controlled experiments with adequate statistical analyses of the results is also an important contribution of the thesis. Again, the proper assessment of the level of the contribution is made difficult by the lack of comparison to other studies with the same or similar stimuli which probably exist in the literature (e.g., the experiments investigating preference for the golden section of geometric shapes). To evaluate the advantages of the overall approach and cSM it must be granted that the results are consistent with previous studies or the differences and reasons for them analyzed.

Standard validity tests were not included in the processing of the results of the experiments, e.g., replicate the experiments or process only part of the data and compare the remaining part with the predictions of cSM. The derivation of individual preference probabilities is based on only 28 comparisons, which is potentially not enough to estimate the individual probability of preference.

Despite the difficulties to fully evaluate the contributions claimed by the author, the systematic wholistic approach adopted in the thesis combining theory with methodology, specialized software for conducting experiments and data processing, and the large number of experiments to validate the model represent a serious methodological contribution and are a good basis for future developments if the criticisms made are taken into account.

5. Evaluation of the publications behind the thesis

The list of publications consists of many publications in Bulgarian – papers, conference talks, and books, which cover the content of the thesis. The thesis adequately presents the results of the papers which as a number and quality are sufficient for a PhD thesis.

6. Citations from other authors

I am not aware of citations by other authors or reviews in the scientific literature of the publications of the author. It is mentioned in the thesis that some results are cited and used in other studies, but no references are given.

7. Opinions, recommendations, and criticisms.

I believe that the author has accepted a major challenge, proposing a new approach in an area of research with a long and fruitful history. This, in my opinion, is commendable, but at the same time it places very high demands on proving the differences of the new method from the existing ones and its advantages over them.

One major criticism that has already been mentioned in the section with the evaluation of contributions is the direct comparison of cSM with other existing methods, the analysis of the differences and the outline of the application areas in which the proposed approach has advantages, and the analysis of these advantages (the so-called scope of approach).

cSM fixes the space of stimuli by suggesting that two levels for each feature defining the volume of the model are sufficient. This claim is not substantiated by evidence.

The multidimensional scaling and unfolding approaches aim to find a space of a certain dimension and metric, based on similarity or preference estimates, which most accurately reflects the empirical results. The goal of the method is to construct a two-dimensional or three-dimensional space that can be easily interpreted. In this space, stimuli which can have otherwise a large number of features are positioned, together with the participants. In some cases, it is necessary to use non-Euclidean metric, such as the so-called "city blocks" metric.

In cSM, the stimulus space is fixed with a Euclidean metric and in it is directly evaluated for each point in it how close it is to the so-called. ideal point of the person or group of persons examined. This is done by assuming that the probability of preference is the same function of distance as in psychological space. The latter assumption is not clarified in the dissertation and requires careful discussion.

The very dependence of probability on distance (a nonlinear function of the distances to power n , where n is the dimensionality of psychological space) requires additional analysis, which should also include empirical support of the idea of the real existence of a reference stimulus. The dependence of probability on the dimensionality of the psychological space raises the question of what would happen in high-dimensional spaces, e.g., with $n=10$. In such spaces large effects of distances above 1 and negligible ones for distances below 1 can be expected.

From the point of view of the "spirit" of multidimensional scaling, the specific relationship of the probability of choice and the distances between stimuli in psychological space may be subject to fitting, minimizing some error function (in cSM the so-called matching factor). It would be interesting to see what form of this dependence gives the best results (e.g., for what power of the distances between stimuli the best description of the data is obtained).

Such an analysis would also require a change in the way data is collected, which may include the presentation of all pairs several time in randomized order, to allow for a more accurate assessment of the individual probabilities of preference, which are currently 1s and 0s and this can lead to additional errors in the evaluation of the probabilities.

8. Conclusion

The author demonstrates the necessary knowledge and expertise in the scientific field of the dissertation, despite the lack of an overview of contemporary literature on some of the topics covered. The presented thesis is a large-scale study which includes the introduction of a new theoretical approach, the creation of a software for its use and the approbation of the developed methodology in numerous interesting experimental situations. The design and statistical treatment of the data of the experiments show a good knowledge of the statistical methods used in the field.

There is no doubt about the personal involvement of the author, who is the only author of most of the articles on which the dissertation is based on as well as of the software. He is also the only author of the first publication which sets out the cSM method (Panov, 2000).

The thesis is based on numerous articles and two books. All articles are published in Bulgarian journals and collections. It would be good, especially given the author claims for contributions and innovation, to try to publish the main results in an established scientific journal in the domain of the thesis. Thus, the proposed approach and empirical data will be evaluated by experts in the field, and this will be a motivation for further developments.

In conclusion, despite the remarks made and considering the significant number of published theoretical and empirical studies that meet the requirements of the scientific field, the creation of specialized software available to Bulgarian specialists and the creation of a methodology for the design and implementation of experiments on preference choices, I strongly recommend that Ivaylo Panov be awarded the educational and scientific degree "Doctor".

20.04.22

Signature

