Some Comments on Dongling Huang and Lan Luo's "Consumer Preference Elicitation of Complex Products Using Fuzzy Support Vector Machine Active Learning"

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Dongling Huang and Lan Luo's new article in the INFORMS journal *Marketing Science* proposes the use of collaborative filtering and fuzzy support vector machines (SVMs) in adaptively selecting each subsequent question to elicit conjoint partworths. This is an excellent paper, and of great interest to practitioners.

Since its inception in 1971, conjoint analysis has been the subject of constant research and development by a large number of academics as well as practitioners. This has led to important new capabilities, such as choice-based conjoint (CBC), Hierarchical Bayes (HB) CBC, adaptive choice-based conjoint (ACBC), and the availability of commercial software (such as Sawtooth Software). These innovations make it easy for practitioners to create, field and analyze conjoint analysis surveys. With experience we practitioners learn which of the many innovations are appropriate for which problems. For example, HB CBC enjoys widespread use today by large corporations, which use it to make important business decisions.

Many of the innovations that have been developed expand the capabilities of conjoint analysis, enabling it to deal with larger numbers of attributes and levels. For example, many two-stage conjoint analysis techniques, which address consideration and then choice, use the first (consideration) stage to identify "must-have" or 'must-not-have" (non-compensatory) attributes. These non-compensatory attributes can then be left out of the choice tasks, thereby simplifying the problem.[1] Still, improvements in this regard have lagged behind increases in the number of attributes of many popular consumer products, e.g., smartphones and tablets.

[1] Gaskin, Steven, Theodoros Evgeniou and Daniel Bailiff (2007). "Two-Stage Models: Identifying Non-Compensatory Heuristics for the Consideration Set then Adaptive Polyhedral Methods within the Consideration Set," *Proceedings of the Sawtooth Software 2007 Conference, Santa Rosa, CA.*

Fortunately, many problems enable practitioners to hold "all else equal," but some problems require the analysis of more attributes and levels.

Other innovations have come about due to a desire to model the consumer decision process. By observing whether or not respondents would consider a set of product profiles, decision heuristics can be identified that lead to the consideration sets observed.[2] [3] [4]

Operations Research (OR) methods have also been applied to conjoint analysis. Rather than using a regression model on the complete set of choices to develop partworths, OR methods are used in adaptive conjoint (where questions asked are based on previous answers) to reduce the size of the solution's feasible region, question by question. This is done until a globally optimal set of partworths is identified. Until recently, though, getting the next question from the algorithm quickly enough so that the respondent does not have to wait too long between questions has been a challenge when there are many attributes and levels.

When there are a large number of attributes and levels, one question that can arise for some types of studies is, what are the various decision processes consumers use when making a purchase? What attributes do they evaluate, and how? Min Ding and coauthors have done a good deal of research on this topic, and have come up with a way to elicit and evaluate decision rules in an unstructured way.[5]

Dongling Huang and Lan Luo's "Consumer Preference Elicitation of Complex Products Using Fuzzy Support Vector Machine Active Learning" fits into this research stream very nicely. It enables adaptive trade-off questions to be formulated quickly, thereby minimizing delays for respondents. The fuzzy SVM –based method can handle products with many more attributes/attribute levels than current adaptive conjoint methods, which provides practitioners with a useful solution for preference elicitation of complex products. Because the

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[2] Hauser, John R., Min Ding and Steven P. Gaskin (2009). "Non-compensatory (and Compensatory) Models of Consideration-Set Decisions," *Proceedings of the Sawtooth Software 2009 Conference, Delray Beach, FL*

[3] Daria Dzyabura and John R. Hauser, "Active Learning for Consideration Heuristics," Marketing Science, 30, 5 (September-October), 801-819.

[4] John R. Hauser, Olivier Toubia, Theodoros Evgeniou, Rene Befurt, and Daria Dzyabura (2010), "Disjunctions of Conjunctions, Cognitive Simplicity and Consideration Sets," Journal of Marketing Research, 47, (June), 485-496.

[5] Ding, Min, John Hauser, Songting Dong, Daria Dzyabura, Zhilin Yang, Chenting Su and Steven Gaskin (2011). "Unstructured Direct Elicitation of non-compensatory and Compensatory Decision Rules," *Journal of Marketing Research*, Vol. 48 (February), 116-127.

fuzzy SVM estimation time is primarily scaled by the total number of questions presented to each respondent, instead of exponentially with the number of attributes and levels, it can deal with a larger number of attributes and levels. The fuzzy SVM method also possesses some robust properties when the respondent incurs response errors in the survey.

However, there is still one bottleneck that is preventing us from dealing with even more attributes – the cognitive capacity of survey respondents. This boils down to the number of attributes and levels that consumers can realistically review on a screen during the choice tasks. The number of attributes, the length of the level descriptions and the use of visuals and incentive compatibility may all have an effect.

I believe that an interesting research effort would be to combine the research we've just reviewed into a larger process that utilizes the best features of each:

- Unstructured direct elicitation
- fuzzy SVMs
- ACBC
- HB CBC

If we could do this for problems with really large numbers of attributes, we'll advance conjoint analysis further. Current one-stage HB CBC methods are appropriate for many of the current applications of conjoint analysis, but the more sophisticated methodologies could be very helpful in the right situations. I hope that researchers will collaborate to take up this challenge, and I look forward to seeing the results.