

Global vs. local Card Forming: Discrete alternatives of SpAM and total-set PRaM for evaluating conceptual judgments in a high-dimensional similarity space

Stefan Schneider¹[000–0001–6572–5983] and
Andreas Nürnberger¹[0000–0003–4311–0624]

Data and Knowledge Engineering Group,
Faculty of Computer Science,
Otto von Guericke University Magdeburg,
Universitätsplatz 2, 39106 Magdeburg, Germany
stefan.schneider@sschneider.de, andreas.nuernberger@ovgu.de
<http://www.dke.ovgu.de>

Abstract. The Spatial Arrangement Method (SpAM) was proposed as an efficient alternative to the total-set Pairwise Rating Method (PRaM) for the extraction of similarity spaces. Recently, SpAM has been criticized as an approximation to total-set PRaM due to lack of interrater reliability. While total-set PRaM and SpAM are expressed on a continuous scale, we seek alternatives that use only a discrete scale. We present Card Forming, a combination of Free (Card) Sorting and the Form operator. Similar to SpAM, Card Forming allows the user to interact with the global item context. We show how the Card Forming user interface can be modified to a local variant similar to the total-set PRaM. We also present a research methodology to evaluate whether Global Card Forming could be a reliable and efficient alternative to SpAM. The results of a pilot study show that Card Forming can outperform the established citation count in terms of recall in an extrinsic document ranking task.

Keywords: Card Forming · SpAM · total-set PRaM · Reliability · Efficiency.

How can similarity data be collected from human judgments [3]? Traditionally, the most direct elicitation method for determining similarity judgments has been based on stepwise similarity ratings, known as the Pairwise Rating Method (PRaM) (e.g. [2]). Due to the lack of context stability, total-set PRaM additionally displays the full item context for each similarity pair [4]. Both PRaM and total-set PRaM require very many repetitions ($n(n-1)/2$ similarity judgments) to extract the entire similarity space of elements [3]. Goldstone introduced Spatial Arrangement (SpAM) [3], a much more efficient method in which participants

simultaneously order the dissimilarities of objects based on their spatial arrangement. In recent years, SpAM has been widely used for real-world use cases such as organizing movie or music collections [6, 9]. Despite the efficacy advantages, the similarity spaces generated with SpAM have been criticized in terms of interrater reliability [10]. The use of SpAM is therefore questionable, as it is efficient but not reliable.

Based Verheyen’s 4 Caveats [10], a new elicitation method is sought that uses a discrete rather than a continuous scale level. It should also allow for featural representation and not be uniquely spatially fixed. A popular discrete alternative elicitation method is Free (Card) Sorting (e.g. [11]). In Free (Card) Sorting, participants are asked to sort cards (i.e., terms) into piles such that the items in one pile are more similar to each other than items in other piles. This method does not require a predefined categorization, but also allows to express only binary dissimilarities (same stack, different stack) for a given sort [5]. Another, more theoretical, discrete method is to make a distinction using George Spencer Brown’s Form operator [8]. The Form operator makes it possible that “the object has an attribute” relation to be spatially visible. It expresses a crisp relation between object and attribute by using only one operator.

We propose Card Forming as a complementary step to Free (Card) Sorting, which transforms an existing set of unstructured Cards into a concept hierarchy based on the Form operator. Basic Card Forming is by design a global context approach (or global Card Forming), similar to SpAM. It immediately informs the user about the entire concept hierarchy. To obtain a counter design for total-set PRaM as a discrete method, we modify Card Forming to a local user interface. In local Card Forming, only one Card is shown to the user in detail, all others are only shown by their label.

Currently, the use of SpAM in high dimensionality measurement scenarios is questionable [10]. For that reason, participants must create a concept-level similarity space that contains only terms. To have a robust (indirect) measure of reliability and efficiency, we apply an extrinsic evaluation using Card Forming to adapt a document ranking. Based on a reference publication with 100 extracted documents with the highest citation frequency and 3 index terms per document, each participant must extract contextually relevant terms from a given task context (e.g., “Please identify relevant terms that primary deal with the notion of formal concept analysis.”). The participant receives basic domain knowledge based on a fundamental page on the respective topic (e.g. Wikipedia Page about “Formal Concept Analysis”).

To verify that the proposed research methodology works as expected, we conduct a pilot study. This involved a first task run with a corpus of 100 documents and 3 index terms per document. Based on the same task context, one expert marked 43 out of 100 documents as relevant. A novice participant creates a (global) Card Form with 24 out of 300 presented index terms in no

more than 15 minutes. The results give a first indication that more relevant documents can be found based Card Forming than with the plain citation count which already very common (e. g. Google Scholar ranking [1]).

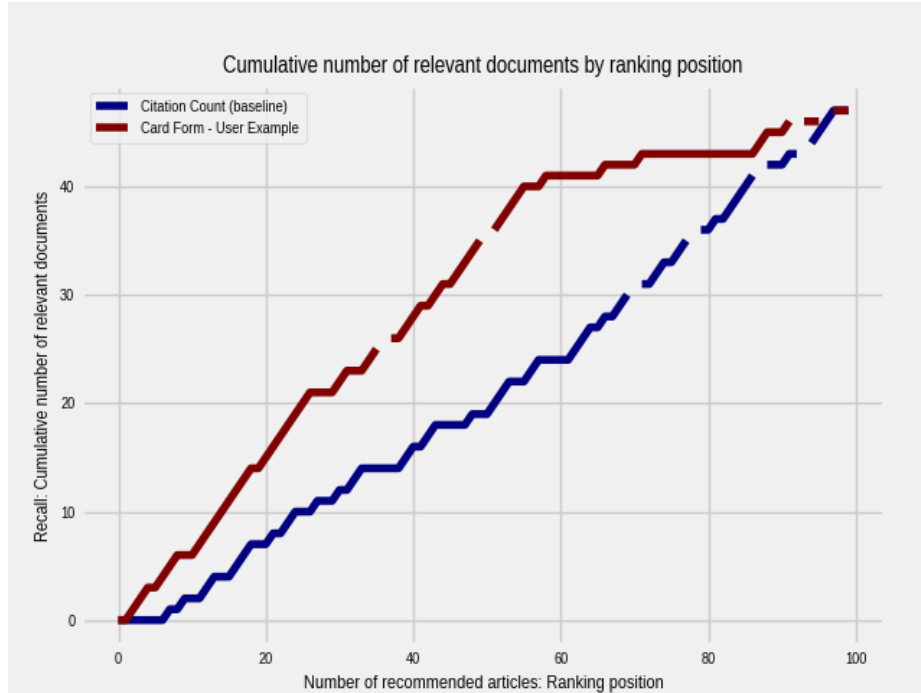


Fig. 1. Comparison of Recall and Number of Document Recommendations: We obtain the following ranking when we compare ranking by number of citations as a baseline compared with the Card Form based ranking.

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