Deriving Conceptual Spaces from human-labeled data

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Abstract. In typical categorization tasks, humans are presented with a sequence of instances and report whether each instance is a member of a given category or not. These labeled data can then be imported into a classifier in order to learn to discriminate the members of the category. However, this labeling technique does not distinguish the most typical instances of that specific category. We argue that additional information, such as the position of an instance in a conceptual space w.r.t. the prototype of the category, could accelerate the learning process and improve the efficiency of the classifier [2]. Hence, conceptual spaces could act as a framework for categorization in supervised learning.

One could argue that implementing such a labeling procedure would require more effort and time, since humans would have to provide additional metrics in order to obtain the conceptual similarity space. We provide the following suggestions: i) considering passive sources of information (i.e., recording the reaction time of their responses) [2], and ii) using neural networks to map unlabeled data into a psychologically grounded conceptual space [1]. This way, i) we do not require any additional human effort for labeling the data, and ii) we can create an extended training set based on the cases labeled by humans.

In our previous study [2] we examined the relation between the reaction time of responses and the instance typicality in conceptual spaces. The results showed that people responded faster to stimuli with high similarity to at least one of the prototypes of two given categories than to stimuli that were distant from both prototypes, and hence closer to the boundary of the two categories. Generalizing this result to more than two categories (assuming that the instance to be categorized is a member of one of the two categories), we could argue that given a Voronoi tessellation of a two dimensional plane into convex sets, longer reaction times would indicate that the instance lies close to the boundary of the two categories. Such a setting would result in a mapping of the instances in space, avoiding humans to explicitly report any similarity judgments which may include inaccuracies or unconscious biases, such as the categorical perception phenomenon.

In this work we will explore whether such a setting for extracting the conceptual space is appropriate in terms of accuracy, compared to the

traditional approach of using human similarity judgments and calculating the Euclidean distances. We will also evaluate the two approaches w.r.t. the time and effort needed by human participants in both cases. Furthermore, we will investigate the production of a conceptual space that is accurate enough using less human-labeled data, by applying the technique proposed in [1].

References

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