Learning to Rank based on Analogical Reasoning

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Preference learning is a branch of machine learning dealing with the induction of preference models from observed preference information [2]. An important problem in the realm of preference learning is "learning to rank" in the setting of *object ranking*: On the basis of training data in the form of a set of rankings of objects (choice alternatives) represented as feature vectors, the goal is to learn a ranking function that predicts a linear order of any new set of objects [1].

In this paper, we propose a new approach to object ranking based on principles of *analogical reasoning*. More specifically, our basic line of reasoning is formalized in terms of so-called *analogical proportions* [3], and can be summarized by the following inference pattern:

$$\frac{A \succ B,\ A : B :: C : D}{C \succ D}$$

Given four objects A, B, C, D, if object A is known to be preferred to B, and C relates to D as A relates to B, then C is (supposedly) preferred to D.

Our learning method consists of two main building blocks: pairwise comparison and rank aggregation. Assuming training data in the form of pairwise preferences (longer rankings are broken into such pairs beforehand), and given a new set $\mathcal{Q}$ of query objects for which a ranking is sought, a weighted preference (which can be interpreted as a probability) is estimated for each pair $C, D \in \mathcal{Q}$. To this end, the number of preferences $A \succ B$ and $B \succ A$ are counted in the training data, where A and B are in analogical proportion to C and D. In a second step, the (weighted) pairwise preferences are combined into an overall ranking. This is accomplished by means of suitable methods for rank aggregation.

Our first experimental results are promising. On data sets from various domains (sports, education, tourism, etc.), our approach turns out to be highly competitive to state-of-the-art methods for object ranking. Specifically strong performance is observed in situations where prediction requires a kind of knowledge transfer (for example, predicting a ranking of hotels in one city based on preferences for another city). The principle of analogical reasoning appears to be especially appropriate for this type of problems.

References

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In: M. Leyer (Ed.): Proceedings of the LWDA 2017 Workshops: KDML, FGWM, IR, and FGDB.
Rostock, Germany, 11.-13. September 2017, published at http://ceur-ws.org