

Mining Fuzzy Concept Lattices

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Abstract

One of the ways to represent the implicit knowledge in a binary dataset under the paradigm of Formal Concept Analysis [1] is the concept lattice. This lattice allows describing a hierarchical biclustering between objects and attributes of a formal context. Concepts are the fixed points of a Galois connection, describing a closure system. In practice, the computation of such lattice presents a high complexity: the number of concepts can be exponential in the size of the input context. Therefore, there is interest in developing new algorithms that take advantage of the lattice structure to efficiently compute the concept set.

Thus, many algorithms have been proposed to compute the concept lattice in this binary setting in the last years. To avoid the complete enumeration of subsets to check which of them are closed, some pruning strategies have been proposed. For example, the NextClosure algorithm [2] defines a lexic order in which to explore closed sets. Other strategies are based on a recursive tree search accompanied by canonicity tests that allow a more efficient exploration. Those based on the CbO strategy [3], such as FastCbO (FCbO) [4, 5], or InClose [6] stand out.

It is possible to extend this framework to take into account the different degrees to which an attribute could be present in an object. Through this extension, it is possible to model fuzzy situations where the attribute is not 100% present in an object, giving flexibility to the model. In this paper, we extend the previous algorithms for the calculation of the fuzzy concept lattice. We show how the InClose family of algorithms can be extended from the binary setting to the fuzzy one, detailing the differences and how new canonicity tests can be employed in order to reduce the computational cost of determining the set of concepts.

We show that these new algorithms can compete with the state of the art in terms of execution time and in number of operations performed. These algorithms may open a new research line in which optimised algorithms can be deduced and built *ad hoc* for the computation of the fuzzy concept lattice.

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