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Philosophical Foundations of Formal Concept Analysis

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Abstract

Concepts are fundamental to the rational communication through language. In the philosophical process, concepts are used either as instruments or as objects of inquiry, and play a very important role in the expression and organization of knowledge. On the other hand, the notion of *concept* was formally treated in a mathematical theory called *Formal Concept Analysis (FCA)*, which deals basically with data analysis and knowledge processing. Our research aimed the study of the similarities between the philosophical and the mathematical approaches involved in the notion of *concept*.

Key words:

Concepts, knowledge, data analysis.

Introduction

Many philosophers worked on concepts with different approaches, considering them as the intermediary between the world and the mind, or even as something that expresses the essence of a thing. Despite the differences, it is possible to see that philosophers generally agree that concepts are elements of thoughts having at least two characteristics: i) they are applicable to certain objects (i.e., its extension) and ii) they express the properties that all the objects satisfying them have in common (i.e., its intension). *Formal Concept Analysis* is a mathematical theory which deals with a formalization of that notion of concept, defined in terms of any two sets A and B , where A is the set of objects (i.e., its extent), B is the set of properties (i.e., its intent) and I is a binary relation that associates to each object some properties. These concepts are determined and represented in a systematic form of data named *formal context*, of which their relations of implication and dependency are exhibited through a line diagram. Given that the intuitive and formal notions have some similarities, since FCA was developed upon well-established philosophical background, we present a study and comparison between these notions, through an interdisciplinary approach.

Results and Discussion

Our research had two basic texts. For the study of Formal Concept Analysis, the book *Formal Concept Analysis: Mathematical Foundations* (1999), by Rudolf Wille and Bernhard Ganter. For a presentation of the notions of concepts in philosophical inquiries, the book *What is concept?*, by Benoit Hardy-Valée. Moreover, works of Plato, Aristotle, Porphyry of Tyre, Kant and Frege were also objects of study, in which we found shared characteristics concerning concepts that were compared to the formal notions presented in the mathematical theory.

One of these characteristics worked by the studied philosophers is the relation between objects and attributes in the notion of concept. Whether directly or indirectly, the concept is seen as something applicable to certain objects having some properties in common. For example, in the platonic dialog *Menon*, Socrates is

searching for the essence of *virtue*, and we can see that this essence is some property present in every case that he calls *virtuous*. The cases and properties have to establish a relation that serves as criterion for the notion of *virtue*. The Formal Concept Analysis conserves that relation between objects and properties, but in a more precise way, as it does with the notions of *context*, *hierarchy*, *implication* and so forth.

Conclusions

We are able to comprehend that the notions of *concept* present in the philosophical inquiries form the background for the most basic definitions in the Formal Concept Analysis. This makes possible for a mathematical theory to work with a set of data disposed in a meaningful and clear picture, established upon relations that are rationally supported, because terms, objects and properties are components of our natural use of the language. On the other hand, Formal Concept Analysis can contribute to philosophical thinking, for example, in the way that it contemplates the notion of concept within the context it belongs. When we think about the development of the language or of a theory, the acquisition of new concepts requires also a new disposition of the relations between the previous terms we possessed. These relations could be seen easier by a FCA software than by our rational skills.

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¹ GANTER, B.; WILLE, R. *Formal Concept Analysis: Mathematical Foundations*. Berlin: Springer, 1999;

² HARDY-VALLÉE, B. *Que é um conceito?* Tradução: Marcos Bagno. São Paulo: Parábola, 2013.

³ PLATÃO. *Mênon*. Tradução de Maura Iglésias. Rio de Janeiro: PUC-Rio. Loyola, 2001.