Chapter 3
Exceptions in Ontologies: A Theoretical Model for Deducing Properties from Topological Axioms

Christophe Jouis
Université Paris III, France

Julien Bourdaillet
Université de Montréal, Canada

Bassel Habib
LIP6, France

Jean-Gabriel Ganascia
LIP6, France

ABSTRACT

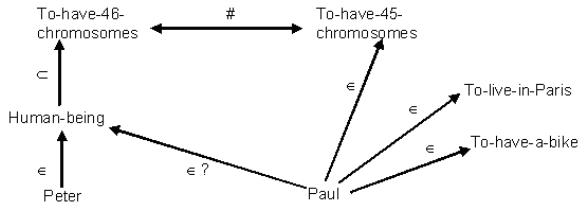
This chapter is a contribution to the study of formal ontologies. It addresses the problem of atypical entities in ontologies. The authors propose a new model of knowledge representation by combining ontologies and topology. In order to represent atypical entities in ontologies, the four topological operators of interior, exterior, border and closure are introduced. These operators allow to specify whether an entity, belonging to a class, is typical or not. The authors define a system of topological inclusion and membership relations into the ontology formalism, by adapting the four topological operators with the help of their mathematical properties. These properties are used as a set of axioms which allows to define the topological inclusion and membership relations. Further, the authors define combinations of the operators of interior, exterior, border and closure that allow the construction of an algebra. They model is implemented in AnsProlog, a recent logic programming language that allows negative predicates in inference rules.

INTRODUCTION

Some entities belong more or less to a class. In particular, some individual entities are attached to classes whereas they do not check all the properties of the class. To illustrate this phenomenon, let us consider the ontological network below (see Figure 1). This network corresponds to the seven following declarative statements:

DOI: 10.4018/978-1-61520-859-3.ch003

Figure 1. The element [paul] does not satisfy all the properties of the class [human-being]



1. A human being has 46 chromosomes
2. Peter is a human being
3. Paul is a human being
4. Paul has 45 chromosomes
5. Paul lives in Paris
6. Paul has a bike
7. One thing can not have at the same time 46 chromosomes and 45 chromosomes

Because [Paul] is a [Human-being], he inherits all the typical properties of [Human-being], in particular [To-have-46-chromosomes]. A paradox is introduced by the statement (7) because "A human-being has 46 chromosomes" is a general fact but not a universal fact. The statement (1) means "In general, human beings have 46 chromosomes but there are some exceptions to this rule".

A similar phenomenon can be observed with distributive classes. Some subclasses are attached more or less to a general class because some of theirs elements may not check all the properties of this general class. To illustrate this phenomenon, let us consider the ontological network below (see Figure 2).

This network corresponds to the ten following declarative statements:

8. A thing which has an engine is a vehicle
9. A thing which has two wheels is a vehicle
10. A thing which has three wheels is a vehicle
11. A motorcycle has two wheels
12. A motorcycle has an engine
13. There are motorcycles with three wheels
14. A thing can not simultaneously have two wheels and three wheels
15. Paul's motorcycle is a motorcycle
16. Paul's motorcycle has three wheels
17. Paul's motorcycle is red

Figure 2. The individual entity [paul's motorcycle] does not satisfy all the properties of the class [motorcycle]. The subclass [motorcycle-with-3-wheels] does not satisfy all the properties of the class [motorcycle]