Fuzzy Query Answering in Motor Racing Domain

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Abstract. Nuances in natural languages can be useful to effectively describe preferences and constraints over a complex and few formalized domain. In this paper we describe the architecture of a query answering system for the domain of motor racing which uses fuzzy logic and domain knowledge in order to carry out searches dealing with vague expression, either as search constraints or as relationship between entities attribute values.

1 Introduction

In this paper we describe a query answering system to retrieve data acquired in the construction of P-Race system [1]. P-Race is a CBR system developed to support the design of tyre treads for motor racing. It is aimed to represent and use the knowledge of compound designers and race engineers that have to decide which tyres to provide to each racing team.

In this perspective, the most important aspect of the domain are the geometric profile of the racing track and the nature of the track's asphalt (i.e. circuits with many bends and a rough type of asphalt wear tyres in a more relevant way that a circuit with few turns and smooth asphalt). Other relevant aspect of the domain are weather and track conditions, which are useful to select a slick or a rainy tyre type.

While precise data related to the relevant entities in the P-Race system is generally available, the knowledge that make use of those data (such as the description of the relationship between wheater conditions and tyre coumpounds) is not always formalized with a mathematical model, and usually is only described by using natural language. This lead to the impossibility to provide a precise outcome of the value of some high-level properties related to the system (for example, the degree of thermical stress induced in a type by a particular track). These imprecision make difficult, in turn, to understand what part of the data contained inside the database can be useful to solve a particular problem, or to determine with the adequate precision what are the constraints to give at the query answering system.

To avoid this problem, we formalized the ontological representation of the races domain, showing the relationship between the different properties of the concepts in the ontology (Fig. 1 shows a partial view of the P-Race ontology, with

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some of the relevant concepts and properties). This allows a user to indicate the intended results of its query (i.e. "I want to find all races that cause a severe stress in the car's tyres"), delegating to the query answering system to figure out what are the database fields that contains values relevant to determine the stress level. Since, as noted above, a relevant part of the domain knowledge is not formalized, but is described with the natural language, we use fuzzy set theory to handle the meaning of vague and imprecise natural language expression. Our approach differs from fuzzy databases approach [2, 3, 4] because our formalization doesn't allow directly to express uncertain and vague attributes inside the database, but defines the concept of *quality* to model predicates allowing partial truth values, which can be used to formulate *soft constraints* [5] (i.e. constraints that can be fulfit only in a partial degree) over the entities in the domain.

Vague expressions can be used inside the system, to define relationships between concepts properties via a fuzzy rule-based system [6, 7], and it is useful because it allows to use natural language as a flexible query answering language [8]. Natural language queries, in turn, allow the users to formulate query that contains imprecise or vague constraint such as "a few chicanes" or "quite hot temperature". This approach gives the advantage to point on the value of qualitative knowledge, sited in the numerical representation of shared judgements based on qualitative descriptions.

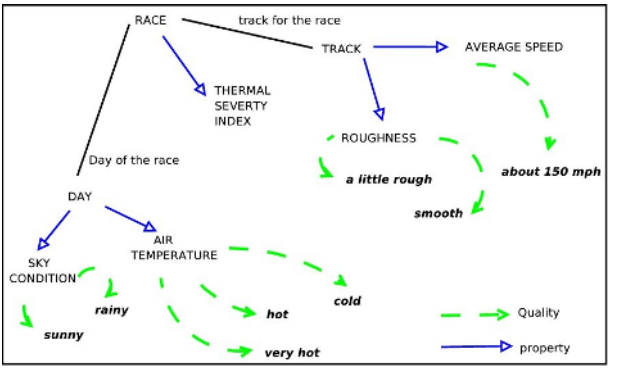

Fig. 1. A snippet of the P-Race domain representation

In the following, we describe the architecture of P-Race Query Answering system, an extension of P-Race that allows to make complex queries over the database used in the system.

2 P-Race Query Answering System Architecture

The proposed system is constituted by four main components. The query parser and semantic analyser convert user input, expressed in natural language, into a tree representation of the user requests. The query evaluation module evaluates the relevance of the instances present in the database according to this