# KNOWLEDGE BASE OF BELGRADE BUS STATION: DOMAIN ONTOLOGY

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*Knowledge base represents a special kind of information systems which can contain several different conceptualizations relating to different domains of interest of the real world, named ontologies. This paper emphasizes the importance of the development of ontologies and formation of the knowledge base of the "Bus station" domain. The domain ontology is developed by the use of CASE tool Protégé-2000 (software package for computer-aided knowledge base design).*

*Key words: knowledge base, ontology, bus station, Protégé-2000.*

Integrated Information System of Belgrade bus station (IIS BAS) has been constantly improving and rebuilding since its implementation. Rapid development of new information technologies and fierce market competition have determined the development of IIS BAS. Bearing that in mind, as well as the fact that bus is a dominant means of transport in Serbia, and that BAS is the biggest bus station in Serbia, the development of the domain ontology is important in a sense of the platform development for interoperability and enabling its multiple use.

The study does not include the domain completely, but the knowledge base is formed on a chosen segment and some of the rules are shown how to get from explicit to implicit knowledge.

**Ontology – Knowledge base**

The word "ontology" was first used in philosophy. It has its roots in the Greek words "on" (genitive "ontos") — "being", and "logia" — "writing about, study of". In philosophy, the word ontology means a theory about the nature of being, or the kinds of existence. For artificial intelligence systems, what "exists" is that which can be represented. The artificial intelligence definition of ontology resembles the interpretation of the philosopher Quine (Quine 1961): what exists is that what can be quantified over. The most broadly used definition is given by Borst [1]: "An ontology is a formal specification of a conceptualization". In context of information technology, ontology represents a unique formalization of concepts within some domain [2]. Ontology defines common vocabulary and terminology used by researchers in need of sharing information from a specific domain. There are several additional reasons why the development of ontology is important:

- Common understanding of the structure of information between people and software agents;
- Repeated use of the domain knowledge;
- Proving the accuracy of the assumptions;
- Separating the domain from operational knowledge;
- Analysis of the domain knowledge.

Recommendation for the ontology development:

- There is no one correct way to model a domain, there are always viable alternatives;
- Ontology development is necessarily an iterative process;
- Concepts in ontology should be close to objects (physical or logical) and relationships in domain of interest.

**Protégé-2000**

Protégé-2000 (software package for computer-aided knowledge base design) is a free, open source ontology editor and knowledge-base framework developed by Stanford Medical Informatics [3]. It is compatible with the Open Knowledge-Base Connectivity (OKBC) protocol. Its models of knowledge are based on class hierarchies (taxonomy). It uses frame-based formalism for knowledge representation. In a frame representation system, a frame is the principal building block of a knowledge model, which represents an entity in the domain of discourse. The Protégé knowledge model [4] is built up from:

- classes (concepts): a class is a set of entities, classes are organized in taxonomic hierarchies;
- slots (roles or properties): slots represent the properties and relationships of the entities in the domain;
- facets (role restrictions): facets describe properties of slots, define constraints on allowed slot values;
- instances: an individual entity from a class is an instance of a class.

Ontology together with a set of individual instances of classes constitutes a knowledge base.

**Research results**

Based on the expert knowledge from the «Bus station» domain, an analysis and partial conceptualization have been carried out. As a result of the analysis, taxonomy of the domain of interest has been formed. For each of the recognized classes slots and roles have been defined, which maintain the relations between classes. For every slot we define cardinality and a type of data which can be received, while for roles we also define: the inverse role (if it exists), its domain and range. Fig. 1 shows the taxonomy of a domain (superclass-subclass) and slots and roles of the class *BusLine*.

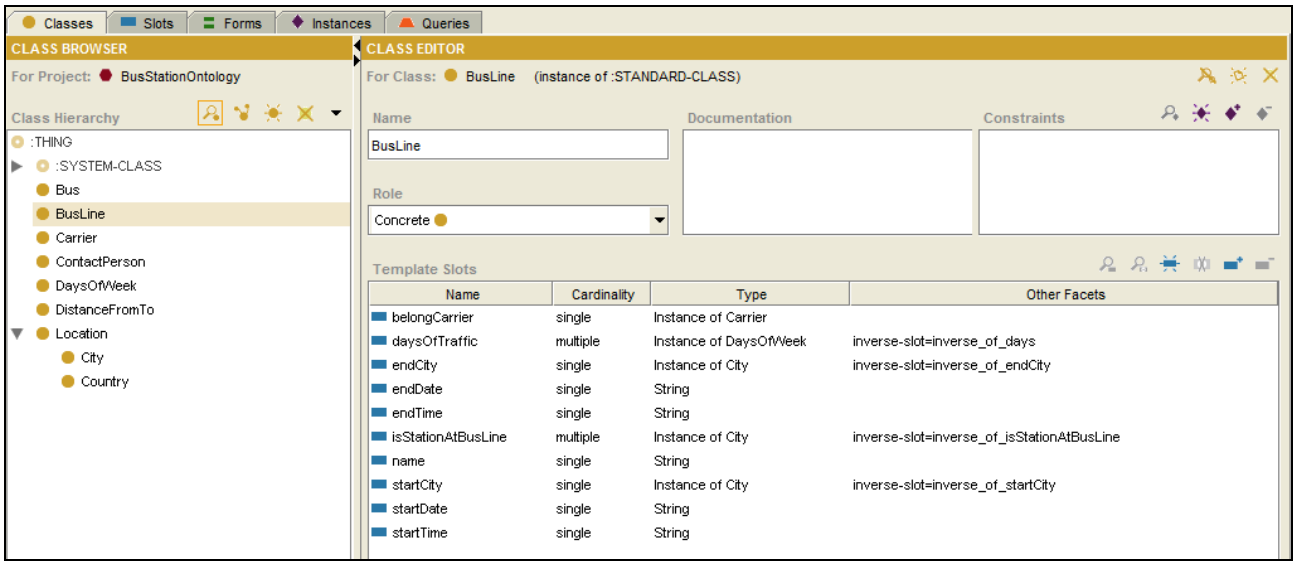


Fig. 1. Taxonomy of domain

The OWL (Ontology Web Language) code has been generated for the developed ontology and acquisition of knowledge. Here is a representation of its part which defines the *City* class as a subclass of the *Location* class. This is the segment of the OWL code:

```
<owl:Class rdf:ID="Country">
  <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
  >Country</rdfs:label>
  <rdfs:subClassOf>
    <owl:Class rdf:ID="Location"/>
  </rdfs:subClassOf>
```

```
</owl:Class>
<owl:Class rdf:about="#Location">
  <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
  >Location</rdfs:label>
</owl:Class>
```

The last step in forming the knowledge base is an acquisition of instances of some classes, including their slots and roles (Fig. 2). Acquisition of instances is carried out through forms for every class from the domain. The form is automatically generated while the class is being projected. During the acquisition of instances of classes into the knowledge base, it is only possible to insert the values for the slots and roles which have already been defined, or during the creation of classes, slots, roles and restrictions.

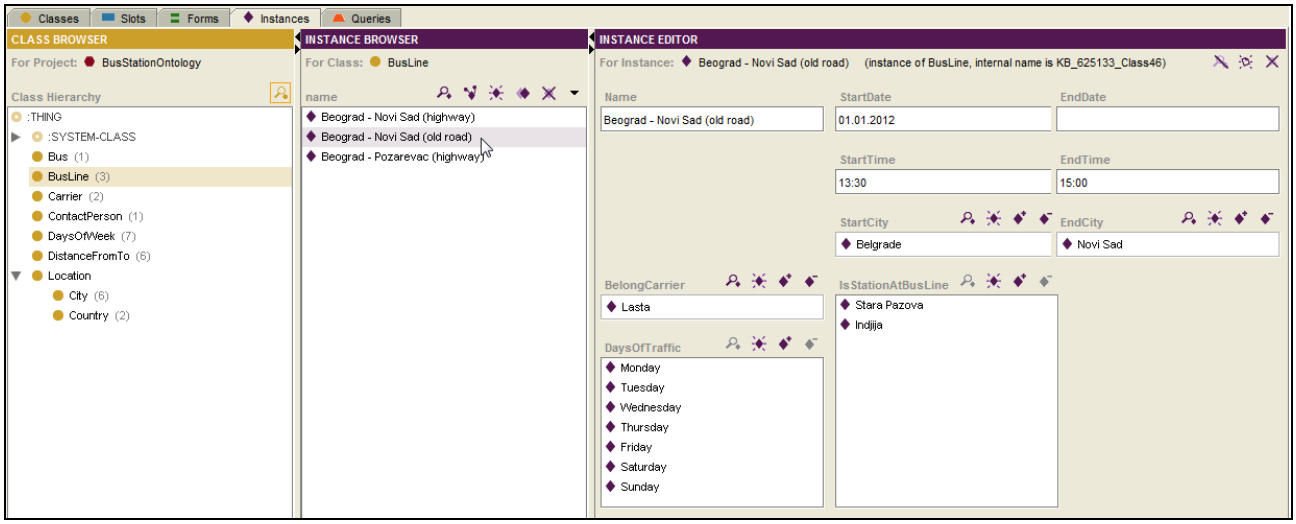


Fig. 2. Instances of the *BusLine* class

With the acquisition of instances of all classes, the knowledge base is being filled with the explicit knowledge (facts, assertions). When the knowledge base is filled with explicit knowledge (instances), it is possible to get to implicit knowledge through *queries*. This process is called *reasoning*. Fig. 3 shows the result of the query *BeogradNoviSadSaturday*. It actually shows all the bus lines which have the city of *Belgrade* as the departure point, and the city of *Novi Sad as* the arrival point, and which operate on *Saturday*.

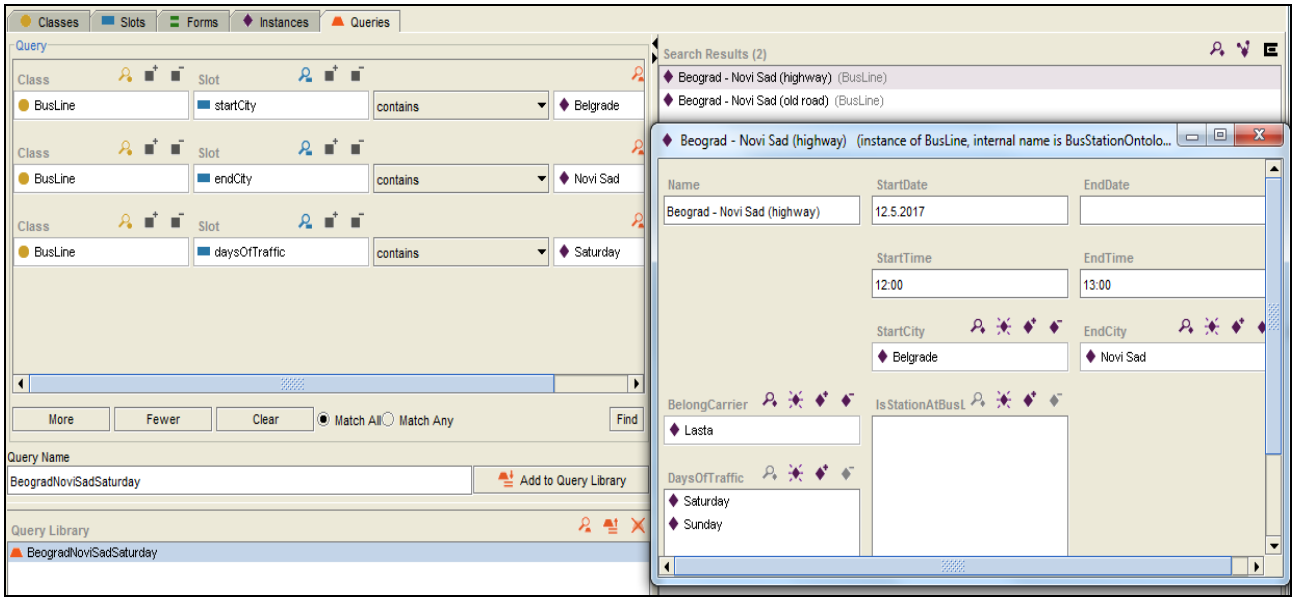


Fig. 3. Result of query (*startCity="Belgrade", endCity="Novi Sad" and daysOfTraffic=" Saturday"*)

All the defined queries are stored in the library of queries and can be carried out at any moment without any additional interventions. The ultimate goal of creation of ontology and base knowledge is a possibility to enable reasoning, i.e. to generate the implicit knowledge about the domain based on the explicit knowledge of the domain.

**Conclusion**

Thus, the new services should facilitate the integration of the developed contents, as well as their maintainance by certain subjects (for example, coordination of bus lines in the whole country), at the same time ensuring an easy use and additional value for the users (carriers, passengers, tourist agencies, etc).

Within the Web context, ontologies have the key role in ensuring the semantic connection of Web contents. Facts represented in this paper can serve as basis for the complete development of ontologies within the bus transport in the country. The complete development of these ontologies would fulfill the following goals:

- Formation of common terminology (vocabulary) of the domain.
- Possibility of uniting the operation of the bus stations.
- Possibility of the formation of the Web-portal.

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**База знаний белградской автобусной станции: онтология домена**

*Базы знаний представляют собой особый вид информационных систем, которые могут содержать несколько различных концептуализаций, относящихся к различным областям интереса реального мира, называемых онтологиями. В данной работе подчеркивается важность развития онтологий и формирования базы знаний домена «Автостанция». Онтология домена разрабатывается с использованием инструмента CASE Protégé-2000 (программный пакет для компьютерной разработки базы знаний).*

*Ключові слова: база знаний, онтология, автовокзал, CASE Protégé-2000*

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