Construction and Representation of a Football Ontology basing on OWL and RDF/RDFS

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Abstract

The W3C considers that the semantic web will be the www's future. Machines and other devices are capable of understanding the data that is based on the semantic web. The ontology, sometimes referred to as the semantic web's backbone, is its primary constituent. Ontologies may be created and edited using a wide variety of tools, however OWL and RDF/RDFS are only sometimes used in research to build ontologies. Despite not utilizing oriented programming, ontologies may be accessed and edited using API OWL. The major goal of this work is to use Protégé to construct an ontology that can access OWL entities. OWL is a useful tool for football sport ontology that may be applied in a variety of situations and times.

Keywords: Semantic Web, Protégé, Ontology, RDF/RDFS, OWL.

1 Introduction

The amount of information available online today is enormous and disorganized. In order to organize the information and link the data, semantic web technologies must be used [1], [2]. The foundation of semantic web technologies is the ontology. Ontology is widely utilized in a variety of industries, including e-learning, medicine, and industry. Ontology describes the connections between concepts when those concepts are connected to a certain domain. To describe this data semantically, the ontology's words and ideas may all be represented graphically. The ontology [3], [4], [5] formally describes how concepts and terminology relate to one another. The ideas and terminology in the ontology are interpreted according to logical rules. The authors of [6] made it clear that factors like the lack of a methodology and related tools might make developing an ontology difficult. Web Ontology Language (OWL) and Resource Description Framework-Schema (RDFS) are suggested for supplying the ontology's core concepts in order to show the data in the World Wide Web Consortium (W3C) [7].

The knowledge of any topic is translated into key phrases using ontology in the web since there is a vast quantity of data spread across several fields or domains in various disciplines [8]. Consequently, the creation of ontologies is crucial in many domains. The construction of the ontology is difficult since integrated tools and procedures are not readily available [9]. The lack of formality in displaying information on the web, according to Abbas in [10], indicates a gap in the use of software engineering in several domains.

Ontologies are being used to codify and arrange the structure in numerous disciplines and domains, as was previously described [11]. The semantic web and artificial intelligence both make extensive use of the term "ontology." Formal descriptions of the ideas, concepts' attributes, and persons inside each concept will be provided [12]. Due to the vast number of football teams and the personnel on each team, including players, coaches, and other staff members, the sport industry is one of the most complicated today. Therefore, creating an ontology about the football teams will be useful to extract knowledge and information due to the vast quantity of information about the football sport. Additionally, it might be challenging to extract or obtain accurate information due to the abundance of materials about football teams from other nations.

Ontologies may be built and constructed using oriented programming languages, plugins, and reasoners using a variety of tools and approaches. In this work, a football team ontology is built using OWL. The suggested ontology in this study was developed utilizing the RDF/RDFS format and the protégé program to read the ontology.

2 Related Works

Ontologies based on RDF or OWL ontologies that are included in W3C 2 can be presented or created using a variety of technologies. This section reviews research studies that have a sport-related focus. Each study employs a different methodology to develop an ontology for a particular sport-related subject. Numerous researches used various sports-related technologies and the semantic web. In [13], public news is extracted from several sports websites and utilized to develop an ontology linked to sports using retrieval information. The primary goal of the researchers in [13] was the football league. In addition to First-Order Logic rules, logical rules are used in this study to develop the information retrieval model. Information is retrieved using Jena SPARQL and RDF query language. A Java application programming language called Jena facilitates the creation of Java code for the semantic web that works with RDF and OWL [14].

An evaluation and illustration of this league's football strategy based on the Knowledge Base (KB) can be found in [15]. The ontology based on KB is offered in two levels, with the structure being in Natural Language text Generation (NLG) and the contents being seamlessly picked. The first layer's implementation is independent of NLG and is based on an ontology. The second layer, which is based on semantic relationships between people, is found at the top level of ontology.

Ramkumar also created an ontology for the sports industry [16]. Five diverse sports games, including football, cricket, athletics, tennis, and rugby, make up the developed ontology. The six phases of the proposed system for developing the sport ontology are: specifying the sport domain; significant concepts related to the sport ontology; the domain's primary classes; the properties of the classes of the sport ontology; specifying the restriction of the properties; and creating instances. The developed ontology is created using the Protégé tool, and its language is OWL. In order to cluster the documents, OWL was translated into a Jena model using Eclipse as the IDE.

A recommender system based on online sporting events was put into place by Nguyen et al. [17]. The authors suggested and implemented a system to gather data from various online sources that is relevant to sporting events in order to make use of the vast quantity of data that is now available on the web. This system makes use of machine learning methods. Later, the data is used using semantic web tools to create an ontology (web engineering). The key contribution was the development of an ontology for several vocabularies that were chosen from a variety of online sources. It is possible to get information from many users and sources using RDF/RDFS. The proposed ontology in is created using protégé as the main application and the form of the ontology is RDF.

The author of [18] created an e-learning system method specifically for the sports industry. The system is built on searching for certain terms, which increases its accuracy while looking for specific information. It also responds significantly faster than more conventionally created systems. The

Constraint Satisfaction Problem (CSP) is used to get the data after the query is produced. When there are 256 documents in the system, the search with the keywords produced a result of 99.6 with 256 precision recall. The recall, however, is precisely 87.5 and 93.7 in conventional systems. The ontology has been created using Protégé program. The aim was accomplished, and the conclusion based on CSP was more accurate, the author concluded.

According to the literature analysis, the majority of ontologies developed in the sports sector do not follow the most fundamental construction guidelines. Because Protégé tool is open source software and is freely accessible from Stanford University, the majority of the writers used it as their primary application to read and visualize the ontology.

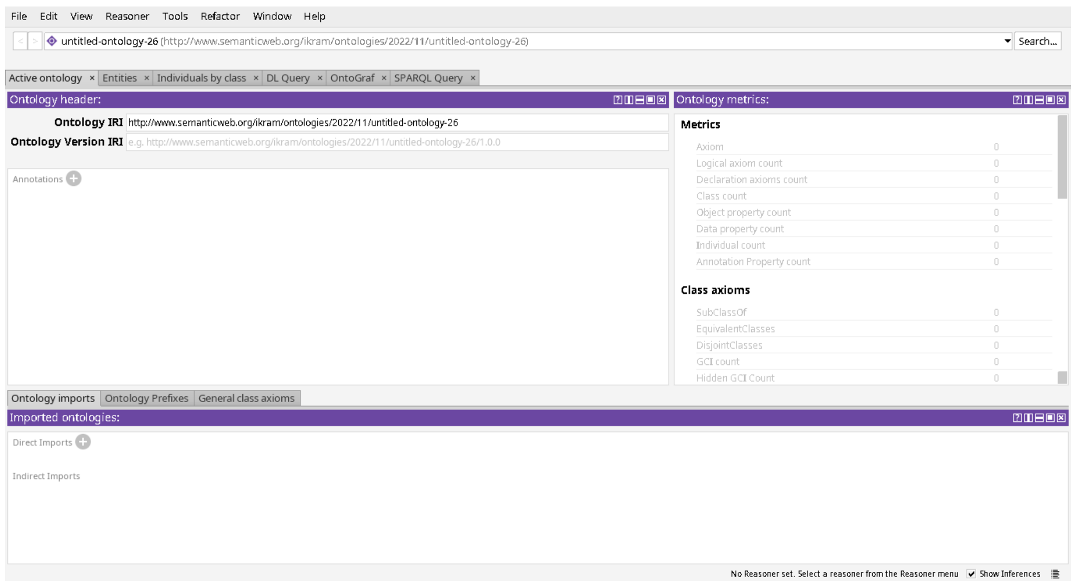

Figure 1. General overview of Protégé (1).

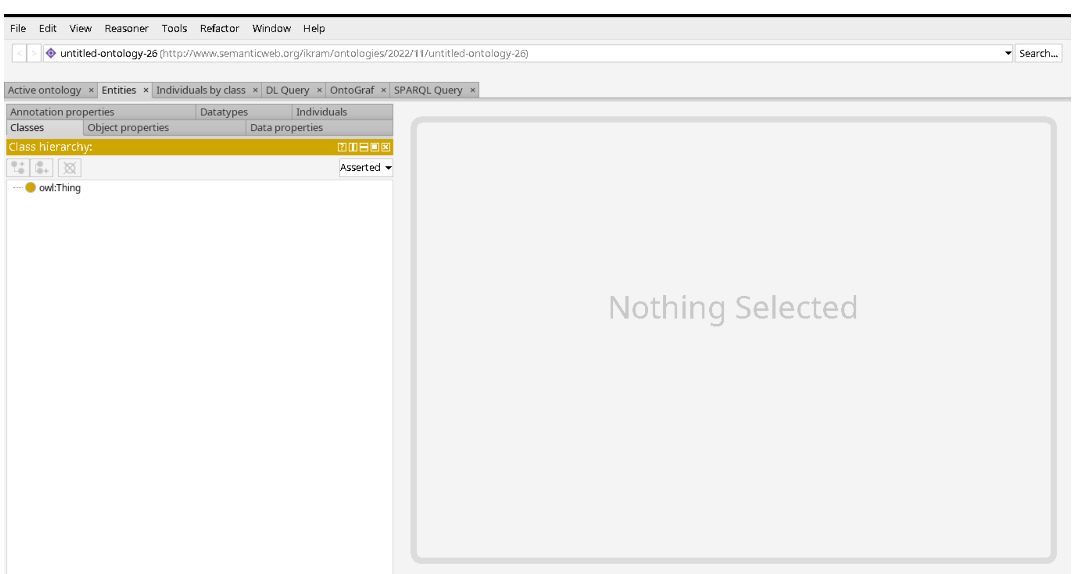

Figure 2. General overview of Protégé (2).

3 Terminology Background

In this section, we gonna cite the details of gerontology and define any technique used in it.

3.1 OWL

It has long been understood that having material that is comprehensible and accessible in a machine-processable form would be advantageous for the Web, and it is generally acknowledged that ontologies play a crucial role in supplying the supporting infrastructure to achieve this objective.

Studying the nature of existence, creatures, and their relationships is known as ontology. Ontology in information science offers a way to provide clear knowledge. An "ontology" is a formal statement of the ideas, kinds, characteristics, and connections among things in a real-world domain.
Formal ontologies offer a context or meaning that is precisely understood to both humans and machines. A shared understanding of information is ensured through ontologies. Ontologies are used in real life to link and characterize diverse and complicated facts. [19]
Foundational notions in (upper) ontologies that are domain agnostic and may be utilized across domains can be reused thanks to ontologies.

Ontologies that are **modular** allow for the separation and recombination of various components according to particular requirements rather than the creation of a single shared ontology. Ontologies' **extensibility** enables further development of the ontology for a variety of applications. Ontologies that are easy to **maintain** can adapt to new needs, make it easier to find and fix errors, and handle other changes. Because ontologies allow design and implementation issues to be separated, they are adaptable to changes in particular implementation technologies.

While ontologies allow design and implementation issues to be separated, they are adaptable to changes in particular implementation technologies.
Uncertainties might result from informal ontologies. Compared to systems based on formal ontologies, systems based on informal ontologies are more prone to errors. Automated reasoning and consistency checking (i.e., is my model logically sound?) are possible with formal ontologies. Taxonomies of ideas connected by subsumption relationships to comprehensive representations of concepts related by complicated relationships are all covered by formal ontologies. Axioms are included in formal ontologies to limit how the concepts are to be interpreted.

3.2 RDF/RDFS

The fundamental RDF model contains an RDF schema (RDFS), which offers I (1) abstraction mechanisms, such as (multiple) class or property subsumption and (multiple) resource classification; (2) domain and range class specifications to which properties can apply; and (3) documentation facilities for names defined in a schema.

The W3C design principles of interoperability, evolution, and decentralization are adhered to by RDF/S. In particular, resource descriptions (by superimposing various statements using the same resource URIs) or schema namespaces (by reusing or improving existing class and property definitions) may be connected in an extendable manner independent of where they are physically located on the Web. [20], [21].

3.3 RDFS vs OWL

By standardizing on a flexible, triple-based structure and offering a comparably limited vocabulary (such as rdf:type or rdfs:subClassOf) that may be used to say things about concepts in your area(s) of interest, RDFS enables you to describe the relationships between things.

OWL is comparable, but larger, stronger, and more evil. OWL gives you the ability to express much more about your data model, it demonstrates how to utilize database queries and automated reasoners effectively, and it offers helpful annotations for applying your data models to actual situations.

In other words, if RDFS is what people in the American Northeast call coffee, OWL is a steaming mug of Italian espresso.

The usage of Example:Beagle as both a class and an instance is what makes this example fascinating. Fido belongs to the class of Beagle, although Beagle itself is a member of the Things Bred in England class.

All of this is completely allowed in RDFS because it doesn't really have restrictions on what statements you can and cannot enter. Contrarily, the aforementioned assertions are really illegal in OWL, or at least in some varieties of OWL (i.e., they are logically inconsistent). Although this may be modelled in OWL, a straightforward consistency check will show the discrepancy. In other words, claiming that anything can be both a class and an instance is illogical.

This brings us to the second significant distinction between RDFS and OWL. The Wild West, speakeasies, and Salvador Dali are all part of the world that RDFS makes possible. More rigorous reasoning is possible in the OWL universe.

Limitations and Compatibility: Why are logic and constraints important to OWL? Technically speaking, the answer has to do with the amount of computer power needed to implement the types of conclusions that all this additional terminology makes possible.
For instance, I may infer that Example:Frank is of type Example:Animal if I know that Example:Frank is of rdf:type Example:Human and that Example:Human is a rdfs:subClassOf Example:Animal.
It turns out that some inferences can be swiftly calculated. Even on the fastest computers available today, certain others can take REALLY long to run. Other conclusions will never be amenable to solution by ANY computer.

4 Methodology and Implementation

In this section we'll use Protégé to implement the ontology desired The hierarchy is splited into eleven classes as it is shown in th figure below.

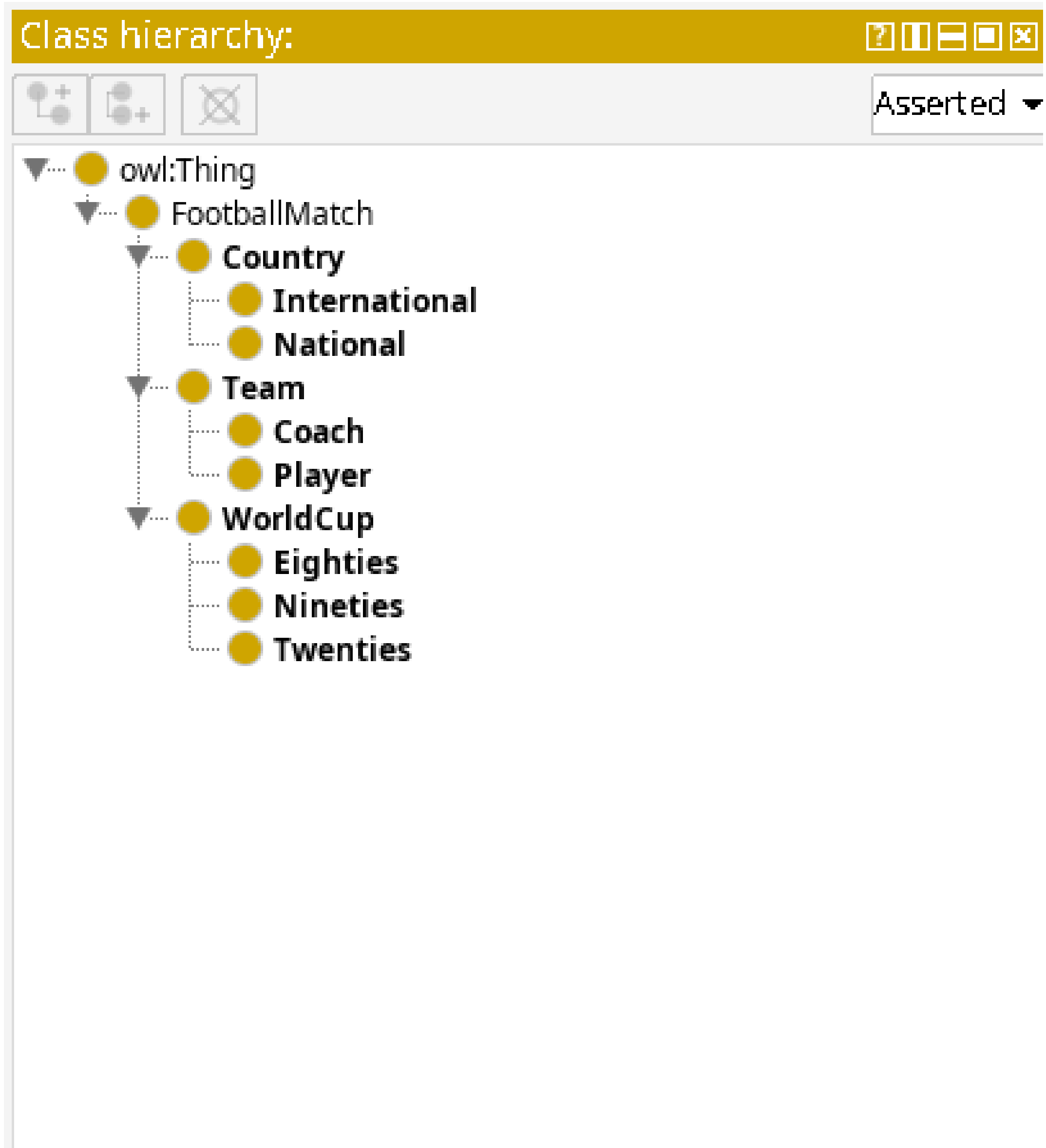

Figure 3. football ontology hiearchy.

The ontology contains eleven classes starting with owl: Thing which makes it actually twelve classes. The main class after Thing present the FootballMatch, in which we found Country with two sorts: National and International. Then we have the Team class which contains the Coach and the Player. Finally the WorldCup class comes with three subclasses about generations or to be more specific decades: Eighties, Nineties, and Twenties.
Here is the ontoloy graph of the classes above.

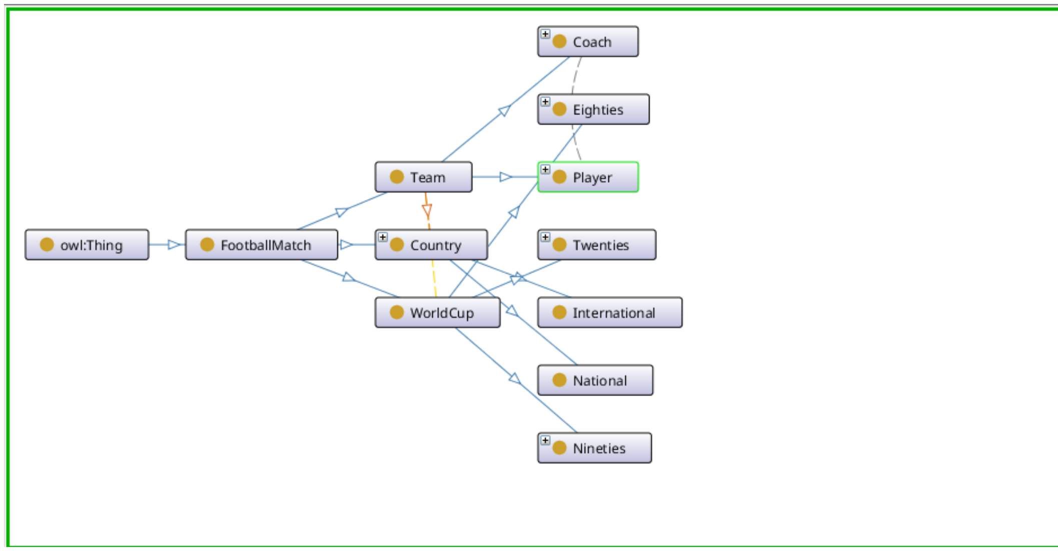

Figure 4. The ontology Graph of the classes of FootballMatch.

A thesaurus expands a taxonomy by giving some conventional relationships between ideas or terms, such as related terms or see also, in addition to the wider term and narrower term relationship found in the hierarchy itself. The class hierarchy structure of an ontology can be expanded with more ambiguous connections known as object and data properties.
Data properties connect a single subject with some type of attribute data, whereas object properties connect two persons (a subject and an object) with a predicate. The specified datatypes for data properties are text, integer, date, datetime, and boolean. It is common, although not always the case, for both object and data properties to be declared with a domain class, such as Person or Event, indicating the class membership of the people acting as the subjects for each object or data property statement. A range class that indicates the class membership of the people acting as the property predicate's objects may also be present in object properties.
This are Object properties in our Football ontology:

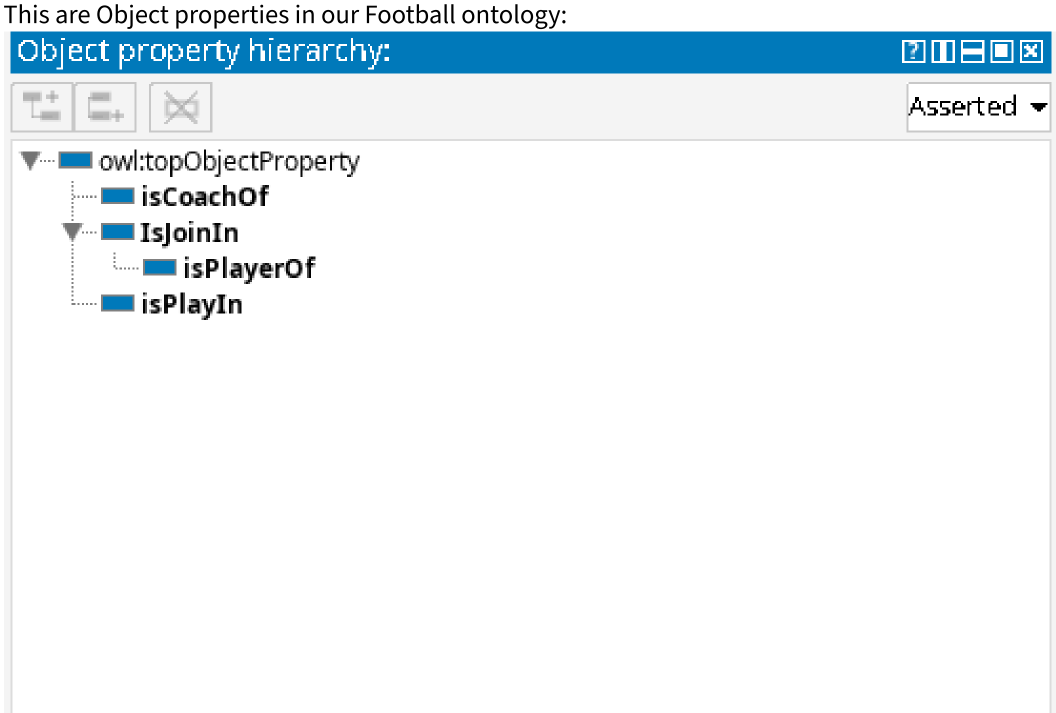

Figure 5. Object properties of FootballMatch.

The object propertes contain four properties isCoachOF, IsJoinIN with the subproperty isPlayerOf, and finaly is PlayIn.

Here are their following domains and ranges:

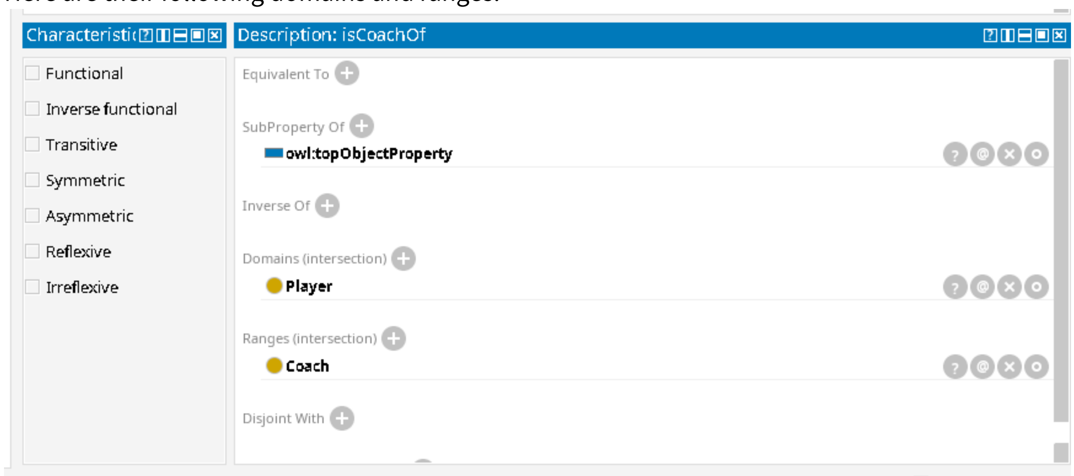

Figure 6. Object properties for isCoachOf

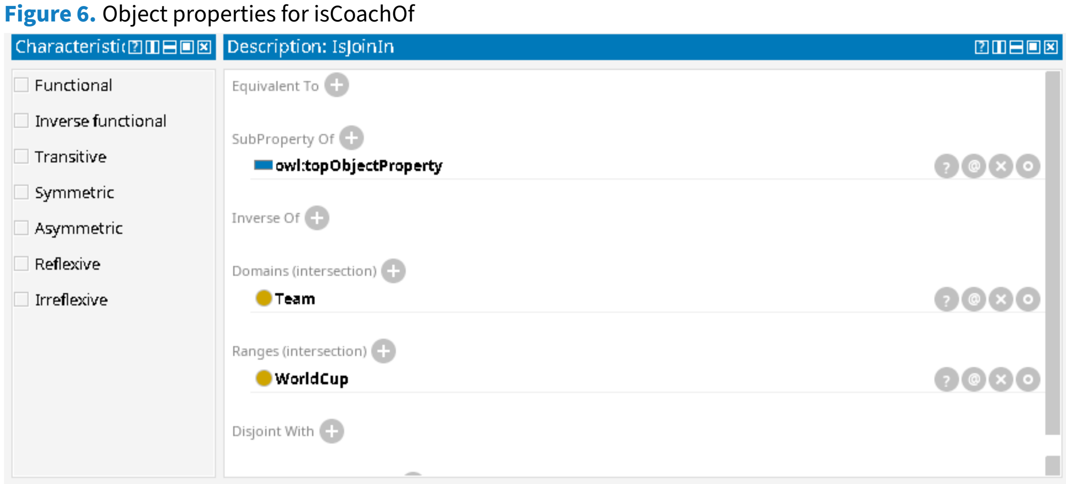

Figure 7. Object properties for isJoinIn

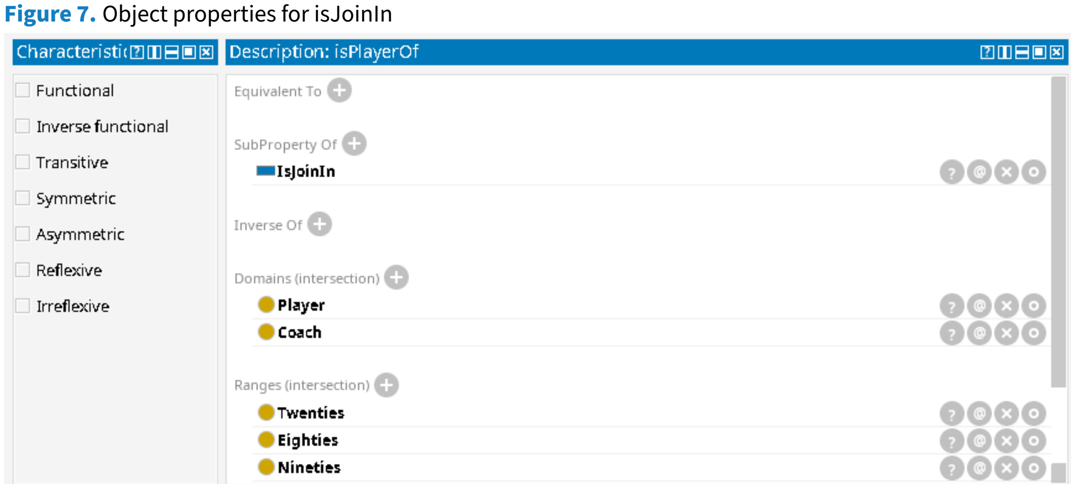

Figure 8. Object properties for isPlayerOf

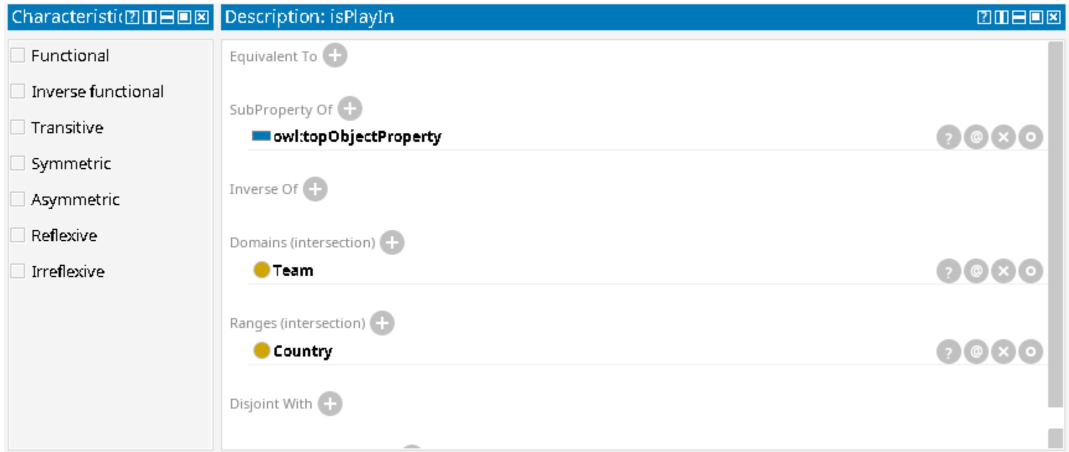

Figure 9. Object properties for isPlayIn

We have the data properties too for age, name ,and natioanlity

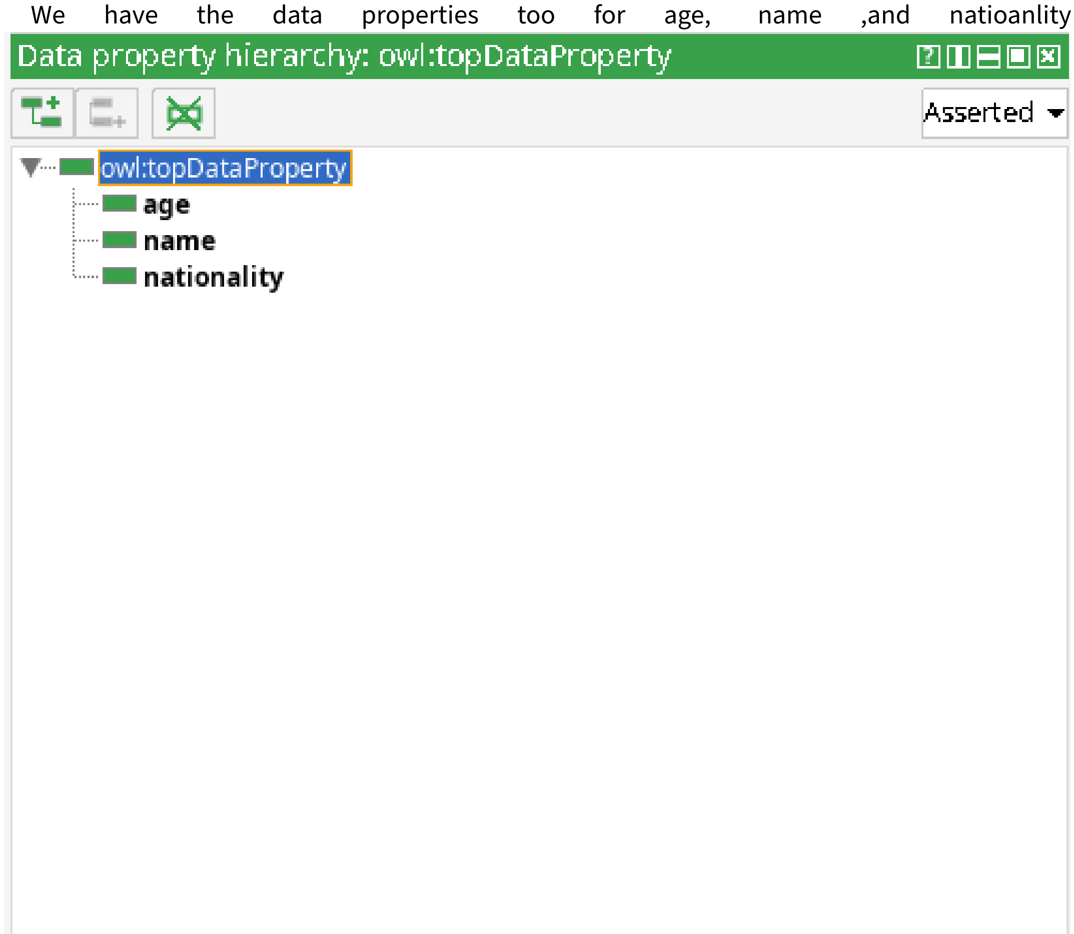

Figure 10. Data properties of FootballMatch.

Concepts, relationships, functions, individuals or instances, and axioms are the five elements that make up the ontology, which may be shown as a 5-tuple [22].

$$Ontology = < C, R, F, I, A >$$

where:

– **Concepts (classes):** are the main formalized elements of the domain [22].
Since the logic, the concepts can be described using specific properties which must be satisfied by them [23].
– **Relationships:** are links between the concepts for representing the ontology structure (taxonomic or not taxonomic).
– **Functions:** are elements with the purpose of calculating information from the other elements.
– **Instances (objects):** are the representation about the main objects within domain according to ontology structure.
– **Axioms:** are the restrictions, rules, logic correspondences definitions [24] which must be accomplished in the relationship between the ontology elements. The axioms can be seen as the smallest unit of knowledge within an ontology [25], [26].

In our Football ontology we hove some restrictions; The Player class has the restriction: The value of the isCoachOf property has at least one instance and the same for isPlayIn property.

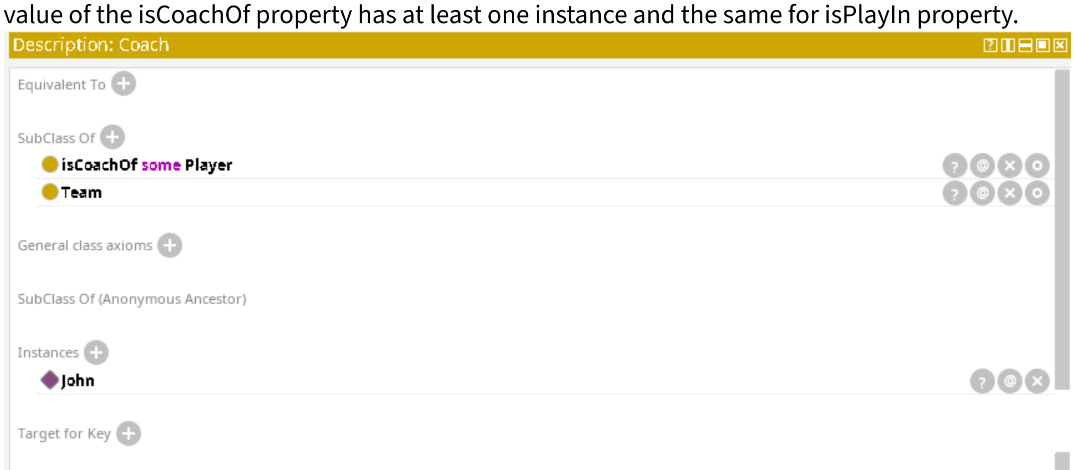

Figure 11. Restriction on Coach class.

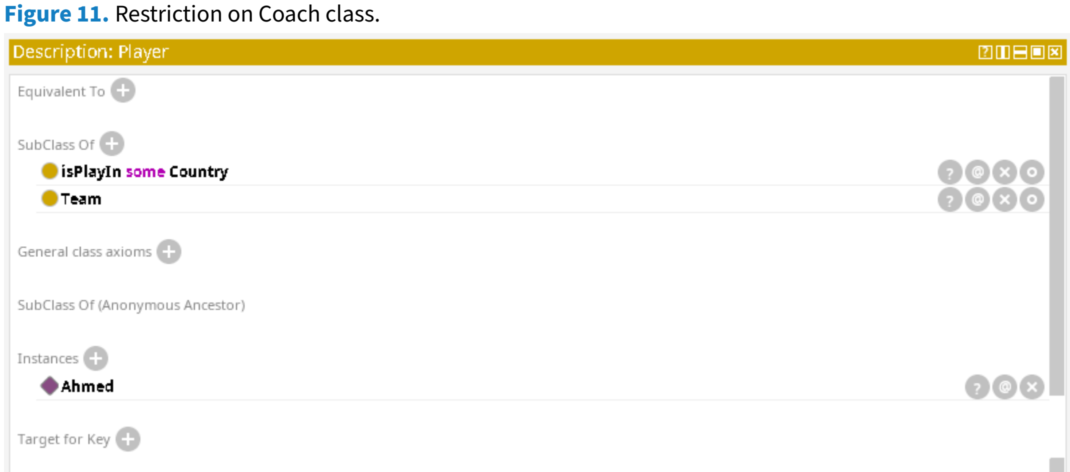

Figure 12. Restriction on Player class.

We have also some other relations or restrictions like *DisjointWith* between the class Country and WorldCup.

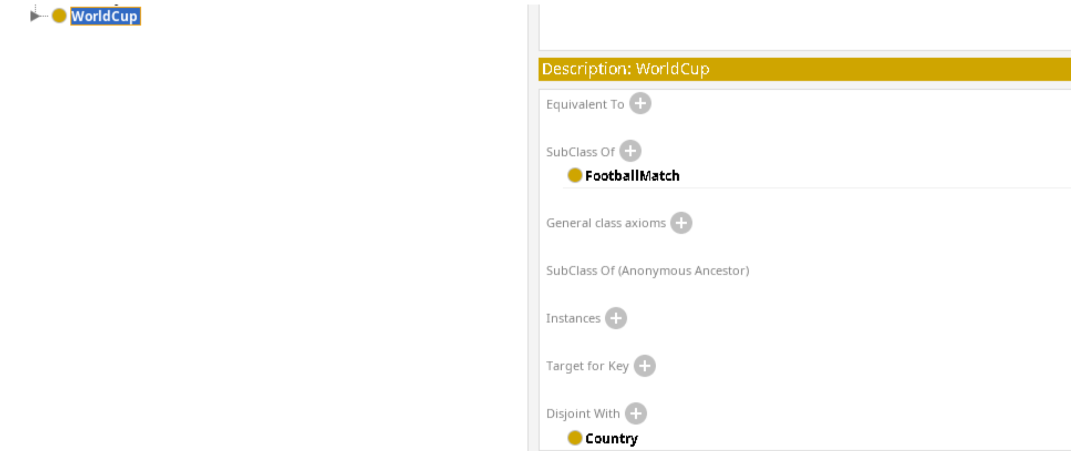

Figure 13. Restriction DisjointWith.

We have create some individuals using the Data proprety to fill in. In our ontology we have an instance for the Coach and another for the Player as it is shown in the following figure.

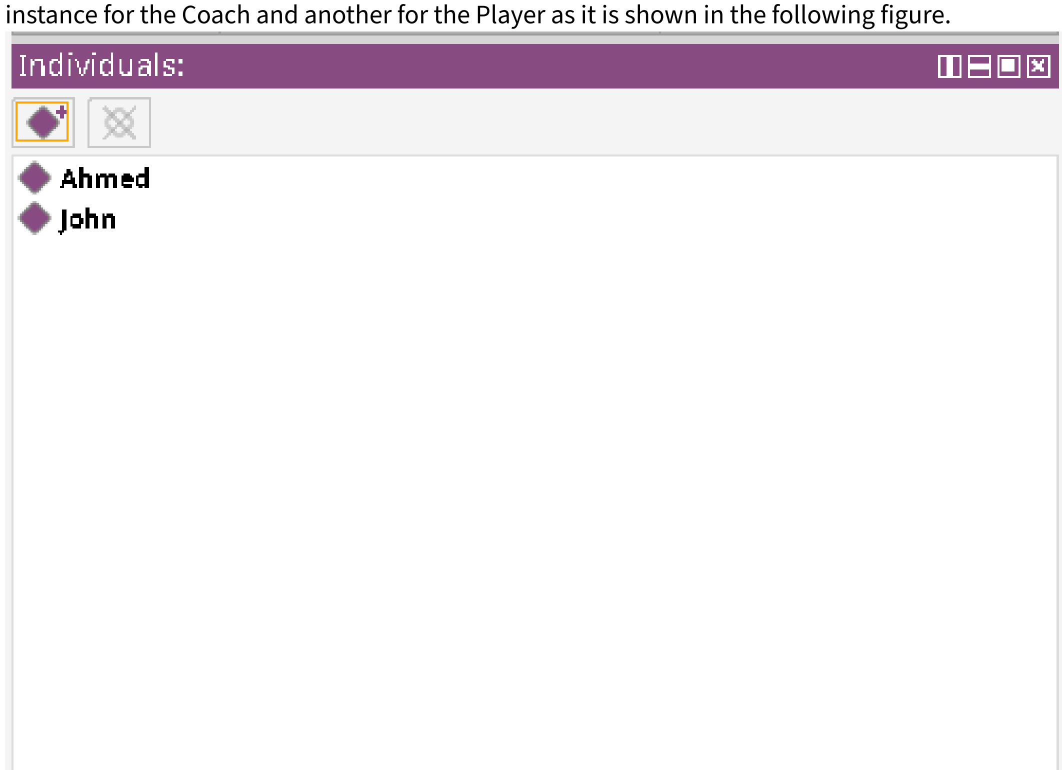

Figure 14. The ontology individuals

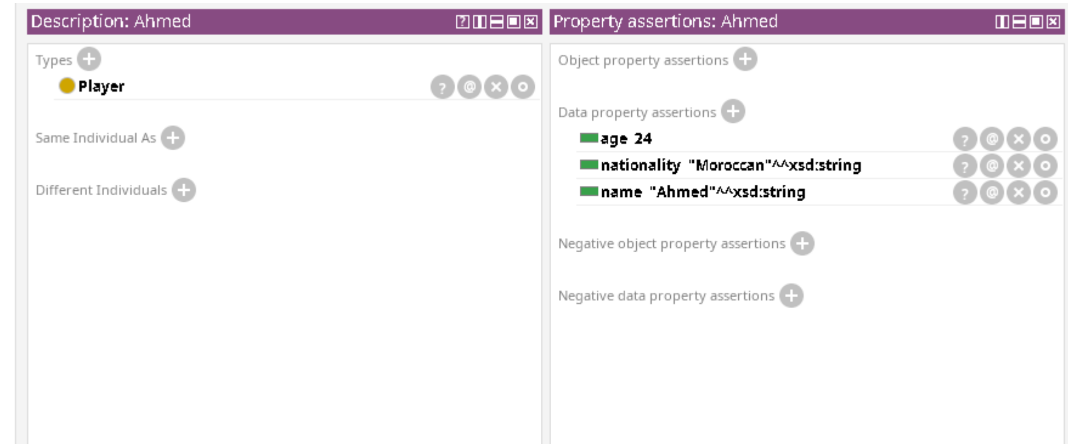

Figure 15. The player instance

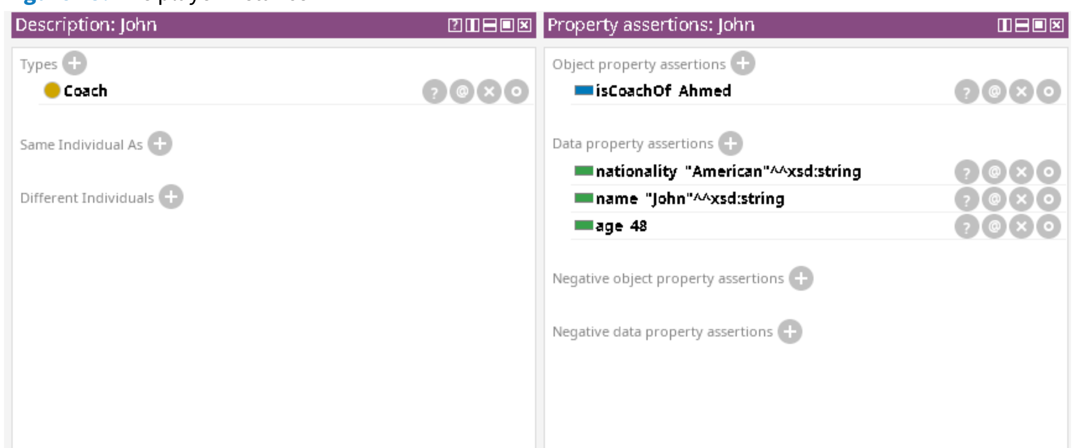

Figure 16. The coach instance

Now the convertion to RDF is called for using some toolsand technics like an RDF validator that would be practical we got the following graph.

```
<!-- http://www.semanticweb.org/ikram/ontologies/2022/9/untitled-ontology-8#isPlayerOf -->

<owl:ObjectProperty rdf:about="http://www.semanticweb.org/ikram/ontologies/2022/9/
untitled-ontology-8#isPlayerOf">
    <rdfs:subPropertyOf rdf:resource="http://www.semanticweb.org/ikram/ontologies/2022/9/
    untitled-ontology-8#IsJoinIn"/>
    <rdfs:domain rdf:resource="http://www.semanticweb.org/ikram/ontologies/2022/9/
    untitled-ontology-8#Coach"/>
    <rdfs:domain rdf:resource="http://www.semanticweb.org/ikram/ontologies/2022/9/
    untitled-ontology-8#Player"/>
    <rdfs:range rdf:resource="http://www.semanticweb.org/ikram/ontologies/2022/9/
    untitled-ontology-8#Eighties"/>
    <rdfs:range rdf:resource="http://www.semanticweb.org/ikram/ontologies/2022/9/
    untitled-ontology-8#Nineties"/>
    <rdfs:range rdf:resource="http://www.semanticweb.org/ikram/ontologies/2022/9/
    untitled-ontology-8#Twenties"/>
</owl:ObjectProperty>
```

Figure 17. piece of code about the OWL/RDF ontology

Using the rdf validator, we get first an organized table of Triples of the Data Model:

Number	Subject	Predicate	Object
1	http://www.semanticweb.org/ikram/ontologies/2022/9/untitled-ontology-8	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3
2	http://www.semanticweb.org/ikram/ontologies/2022/9/untitled-ontology-8#IsJoinIn	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3
3	http://www.semanticweb.org/ikram/ontologies/2022/9/untitled-ontology-8#IsJoinIn	http://www.w3.org/2000/01/rdf-schema#subPropertyOf	http://www.w3
4	http://www.semanticweb.org/ikram/ontologies/2022/9/untitled-ontology-8#IsJoinIn	http://www.w3.org/2000/01/rdf-schema#domain	http://www.se ontology-8#Te
5	http://www.semanticweb.org/ikram/ontologies/2022/9/untitled-ontology-8#IsJoinIn	http://www.w3.org/2000/01/rdf-schema#range	http://www.se ontology-8#Wo
6	http://www.semanticweb.org/ikram/ontologies/2022/9/untitled-ontology-8#isCoachOf	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3
7	http://www.semanticweb.org/ikram/ontologies/2022/9/untitled-ontology-8#isCoachOf	http://www.w3.org/2000/01/rdf-schema#subPropertyOf	http://www.w3
8	http://www.semanticweb.org/ikram/ontologies/2022/9/untitled-ontology-8#isCoachOf	http://www.w3.org/2000/01/rdf-schema#domain	http://www.se ontology-8#Pl
9	http://www.semanticweb.org/ikram/ontologies/2022/9/untitled-ontology-8#isCoachOf	http://www.w3.org/2000/01/rdf-schema#range	http://www.se ontology-8#Co
10	http://www.semanticweb.org/ikram/ontologies/2022/9/untitled-	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3

Figure 18. piece of triples of the data model

Then we have the graph. It's a huge one the following figure shows some pieces.

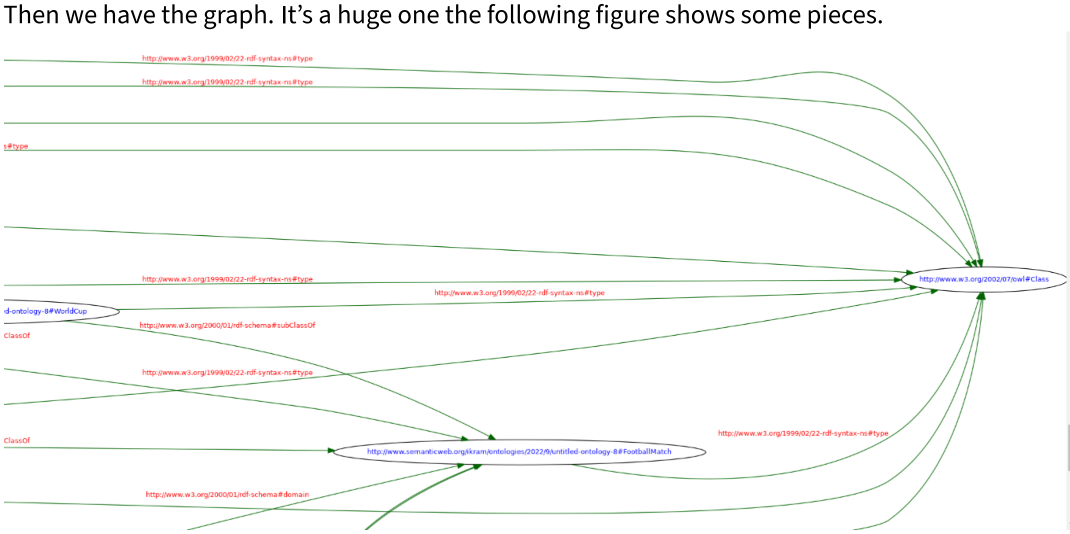

Figure 19. pieces of the RDF graph (1)

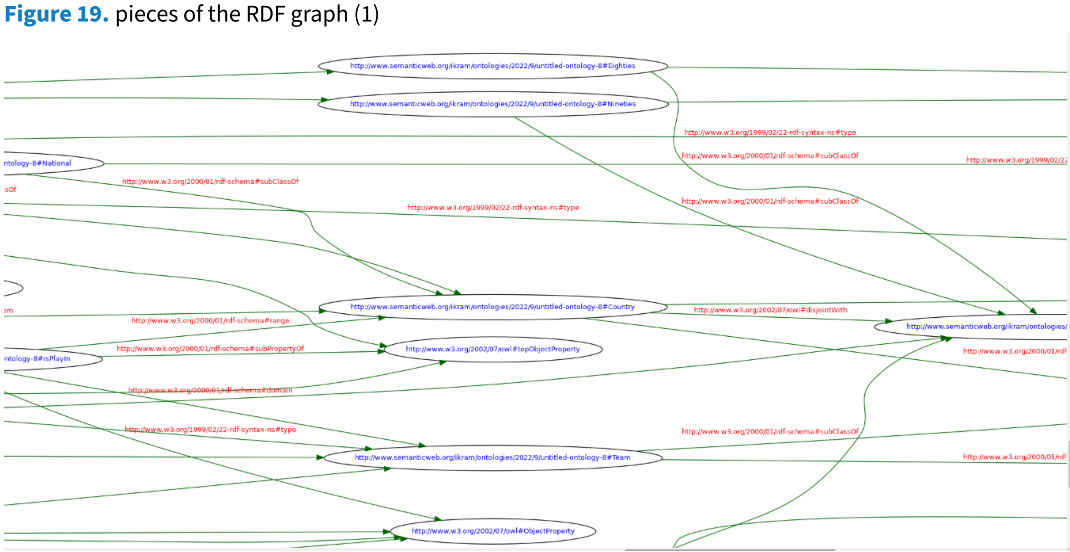

Figure 20. pieces of the RDF graph (2)

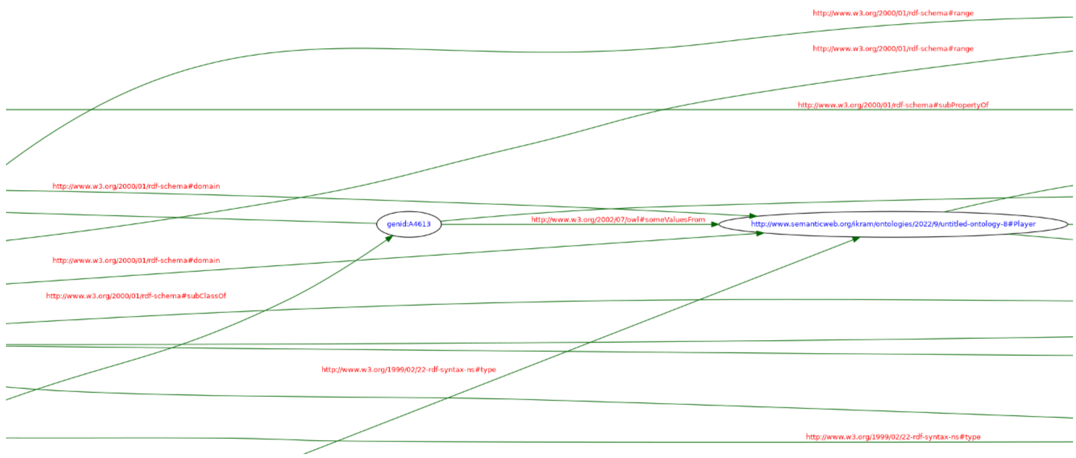

Figure 21. pieces of the RDF graph (3)

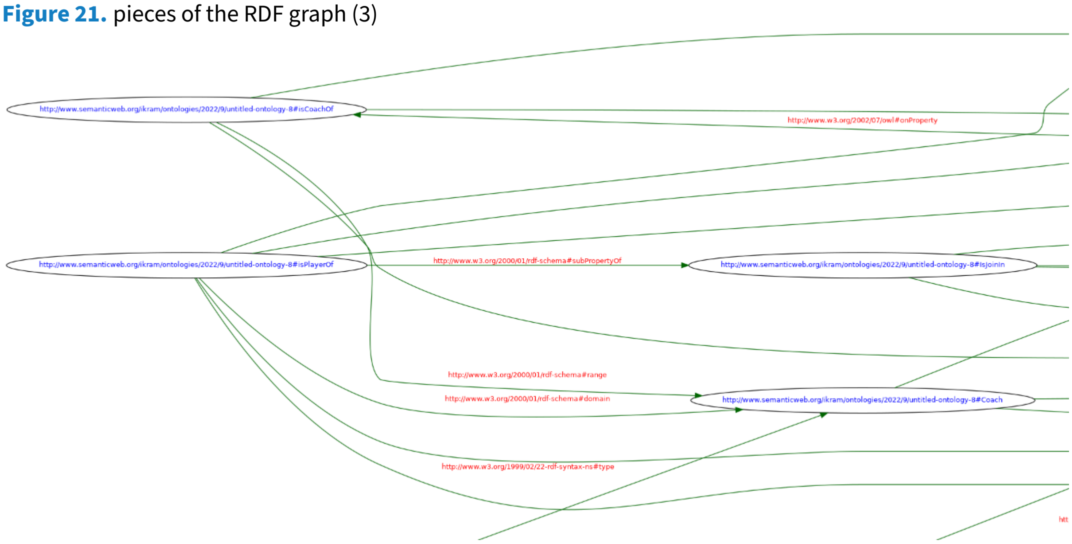

Figure 22. pieces of the RDF graph (4)

5 Conclusion

The ontology is a crucial benchmark for information representation, but it also has the capacity to grow when put to the test. We may state that the ontology validation is assured by prior knowledge provided by a subject-matter expert, and the verification is accomplished by analyzing characteristics and mathematical functions. Using Protégé, a sport ontology has been developed in this research. Numerous studies in the area of ontology development have been evaluated, however the majority of them focus on building ontologies using standard techniques in the same application. It is simple to view the work, arrange it, and make visible its detailed hierarchical structure thanks to the usage of RDF/RDFS and OWL.

A football ontology for scheduling matches has been developed in this work and is loaded in a Protégé application so that it can be read and shown. There are twelve classes in this ontology, and some of the individuals with object and data properties.

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