

Web of Data Project : Create the building blocks of a Semantic Web application for a higher education institution

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1 Introduction

This project was developed for the Web of Data class and aims to implement a Semantic Web application for a higher education institution. For this project, I chose Aix-Marseille University[2] as an example as it is my previous university. The main goal of this project is to demonstrate the benefits of using Semantic Web technologies in higher education institutions, such as improving the management of data and information exchange between different systems. By implementing this application, I aim to demonstrate how Semantic Web technologies can help institutions like Aix-Marseille University better manage their data and provide more efficient services to students, faculty, and staff.

2 RDFS : Resource Description Framework Schema

The schema *project.schema.ttl* represents the classes and properties of a university. It includes all the different organizations that make up Aix-Marseille University, as well as the various job roles, subjects that students are studying and teachers are teaching. There is also the representations of physical places such as campuses, buildings or rooms used to organize classes and activities. Additionally, it includes research teams, research centers, their respective fields. At the top level, the schema defines the different organizations within Aix-Marseille University. These organizations include faculties, departments, and institutes. Under each organization, there are different job roles that exist within the university. These roles include professors, researchers, accountant, president and other administrative staff. The schema also defines the different subjects that students may be studying at the university. These subjects include fields such as science, humanities, social sciences, and business. Finally, the schema includes research teams and research centers, which are responsible for conducting research within the university.

Overall, the schema provides a representation of the various components that make up Aix-Marseille University. By organizing these components into a structured format, the schema can be used to facilitate data management and analysis within the university.

3 RDF : Resource Description Framework

The RDF data *humans_data.ttl* describes various entities related to the previous described RDFS, such as departments, central services, shared services, components, professions such as teachers, students, campuses, and buildings. The data includes information such as the type, name, label, comment, email, age, and department of various individuals, including teachers and students, researchers, president and many others. Additionally, it includes the campus and address of various buildings, such as libraries, gymnasiums, and amphitheatres. The RDF data also describes the relationships between these entities, such as which person works at which department or campus, and which building is located on which campus or for example if the rooms have video projectors or not.

4 Main utilities

Using this schema and its related data, this type of architecture offers a wide range of utilities. It enables us to retrieve a lot of information about teachers, students, or others persons working in specific departments, research centers, or teams. On top of that, by implementing multiple instances, we can gain deeper insights into the structure of a particular university if we implement multiples. In addition, the schema allows us to access multiple details about the university's physical places, including campuses, buildings, activities, rooms, as well as their equipment and capacity. We can also observe various relations among individuals who work in the same department, attend the same courses, or are part of the same research groups or centers. I decided not to incorporate family, colleagues, or other relationships properties, as these have been frequently used in class and are not particularly relevant to a higher education system. The connections among colleagues can be easily determined by identifying persons who work within the same departments.

5 Example of SPARQL Queries

5.1 Student and teacher's subject

In order to organize the classes, we can retrieve all the student and professors that studies and teaches the same subject.

PREFIX : <http://ns.msc.dsai.fr/project/schema#>

PREFIX d: <http://ns.msc.dsai.fr/project/data#>

```

SELECT ?st ?tc
WHERE {
    ?st :isStudying ?m
    ?tc :isTeaching ?m
}

```

5.2 Retrieve a specific person according to relationship

In this example, we query the person who is the dean of the component of Mario.

```

PREFIX : <http://ns.msc_dsai.fr/project/schema#>
PREFIX d: <http://ns.msc_dsai.fr/project/data#>
SELECT ?Dean
WHERE {
    <http://ns.msc_dsai.fr/project/data#Mario>:studiesAtDepartment ?d
    ?Dean a :Dean
    ?Dean :worksAtDepartment ?d
}

```

5.3 Count the number of people working at a given department

Here, we are selecting the number of persons working in the component ScienceTechnology.

```

PREFIX : <http://ns.msc_dsai.fr/project/schema#>
PREFIX d: <http://ns.msc_dsai.fr/project/data#>
SELECT (count(?p) as ?count)
WHERE {
    ?p :worksAtDepartment :ScienceTechnology .
}

```

We can also do it for every department existing :

```

PREFIX : <http://ns.msc_dsai.fr/project/schema#>
PREFIX d: <http://ns.msc_dsai.fr/project/data#>
SELECT (count(?p) as ?count) ?d
WHERE {
    ?p :worksAtDepartment ?d
}
GROUP BY (?d)

```

5.4 Get all the emails of the different professors and their department :

```

PREFIX : <http://ns.msc_dsai.fr/project/schema#>
PREFIX d: <http://ns.msc_dsai.fr/project/data#>
SELECT ?teacher ?email ?department
WHERE {
    ?teacher a :Teacher ;
        :worksAtDepartment ?department ;
        :email ?email .
}

```

5.5 Campuses where we can find a swimming pool :

This kind queries can be used to find a specific building such as library, swimming pool on all the campuses.

```

PREFIX : <http://ns.msc_dsai.fr/project/schema#>
PREFIX d: <http://ns.msc_dsai.fr/project/data#>
SELECT ?c
WHERE {
    ?a a :SwimmingPool
    ?a :onCampus ?c
}

```

5.6 Find the number of welcome capacity in each building of the university :

With this kind of queries professors of administration can find a building or a room corresponding to their needs.

```
PREFIX : <http://ns.msc_dsai.fr/project/schema#>
PREFIX d: <http://ns.msc_dsai.fr/project/data#>
SELECT ?building (SUM(?capacity) AS ?totalCapacity)
WHERE {
    ?room a :Room ;
        :inBuilding ?building ;
        :capacity ?capacity .
}
GROUP BY ?building
```

5.7 Retrieve the names and ages of all the students who are studying "Data Science" and are also studying "Machine Learning":

This kind of queries can be used to find all the students studying multiple specific subject in order to organize an exam session or new classes.

```
PREFIX : <http://ns.msc_dsai.fr/project/schema#>
PREFIX d: <http://ns.msc_dsai.fr/project/data#>
SELECT ?name ?age
WHERE {
    ?person rdf:type :Student .
    ?person :name ?name .
    ?person :age ?age .
    ?person :isStudying "Data Science" .
    ?person :isStudying "Machine Learning" .
}
```

5.8 Find all the rooms with video projectors in each building :

If for a specific class, a professor needs a video projector or other material that we could add, this query can help the administration find a room for this need.

```
PREFIX : <http://ns.msc_dsai.fr/project/schema#>
PREFIX d: <http://ns.msc_dsai.fr/project/data#>
SELECT ?room ?b
WHERE {
    ?room :videoProjector true
    ?room :inBuilding ?b
}
```

6 Conclusion

In conclusion, this project demonstrates the benefits and uses of using the building blocks of a Semantic Web application for a higher education institution. By implementing a schema and data using RDF and RDFS, we can organize and manage data related to universities various components, including departments, buildings, and individuals such as students, professors, researcher and administrative staff. This project also includes some examples of SPARQL queries that demonstrate how this type of architecture can be used to query specific information about a university, such as the number of people working in a particular department, the students that are studying a specific subject or the campuses where we can find a swimming pool or any other building. Overall, this project shows the potential of Semantic Web technologies to help institutions like Aix-Marseille University better manage their data and provide more efficient services to students, faculty, and staff.

7 Future Work

This project can lead to many other projects and can also be improved by implementing new classes, new properties and new data. One of the ideas could be to have much more details about the students such as more information about their teachers, their class, their programs, classmates, their agenda and even the student board and different activities that they organize. We could also improve the building management system by adding floor the buildings, adding more details about equipment available in each room, such as computers, whiteboards, scientific equipment, and other items, as well as the schedules of each building. A last idea we could think of is to add much more data to create a more realistic simulation of a university in order to be able to have more response in our queries. But to me, the project was more about the architecture than the data itself.

References

- [1] Faron, Catherine. (2023). *Web of Data Class*. Lecture presented at Côte d’Azur University.
- [2] Aix-Marseille Université. *Aix-Marseille Université Website*. Retrieved March 31, 2023 from <https://www.univ-amu.fr/fr/public/organisation-daix-marseille-universite>
- [3] DBpedia. *DBpedia Website*. Retrieved March 31, 2023 from <https://www.dbpedia.org/>