Program: CESS

Course Code: CSE 488
Course Name: Ontologies and the Semantic Web

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Table of Contents

1.0 Introduction

The ontology presented herein is designed to model the domain of a university, aiming to provide a structured representation of its various components and their relationships. This report outlines the problem domain, describes the entities and their relationships, and explains the logic behind the ontology's design.

2.0 Problem Description

The domain of a university encompasses a wide range of entities, including faculties, students, courses, majors, minors, staff, and facilities. Managing and understanding these entities and their relationships require a structured approach. The ontology addresses this need by formalizing the university domain and providing a common framework for representing its components.

3.0 Number of Entities

The ontology defines a range of classes or entities:

1. **Administrative:** Staff members responsible for administrative tasks.
2. **Core:** Core courses required for majors.
3. **Course:** Academic courses offered by the university.
4. **Elective:** Optional courses students can choose from.
5. **Facility:** Physical spaces or resources within the university.
6. **Faculty:** Academic departments within the university.
7. **House_keeping:** Staff members responsible for maintenance.
8. **IT:** Staff members working in information technology.
9. **Laboratory:** Facilities for practical work.
10. **Major:** Areas of specialization for students.
11. **Minor:** Secondary areas of study for students.
12. **Non_teaching:** Staff members not involved in teaching.
13. **Office:** Administrative spaces.
14. **Person:** Individuals within the university.

15. **Postgrad_TA:** Postgraduate students working as teaching assistants.
16. **Professor:** Faculty members who teach courses.
17. **Room:** Spaces within buildings.
18. **Staff:** Employees of the university.
19. **Student:** Individuals enrolled in courses.
20. **Teaching:** Staff members involved in teaching.
21. **Toilet:** Restroom facilities.
22. **Undergraduate:** Students pursuing bachelor's degrees.
23. **University:** The university as an entity.

4.0 Number of Relations

4.1 Object Properties

1. **Admits:** Relationship between faculty and admitted students.
2. **admittedBy:** Inverse of Admits.
3. **employs**: Relationship between the university and its staff.
4. **enrolledIn:** Relationship between students and courses.
5. **hasCores:** Relationship between majors and their core courses.
6. **hasCourse:** Relationship between majors/minors and courses.
7. **hasElectives:** Relationship between minors and elective courses.
8. **hasFacility:** Relationship between faculty and facilities.
9. **hasFaculty:** Relationship between the university and its faculties.
10. **hasMinor:** Relationship between majors and minors.
11. **hasProfessor**: Relationship between faculty and professors.
12. **hasProgram:** Relationship between faculty and its program.
13. **hasStaff:** Relationship between faculty and staff.

14. **hasStudent:** Relationship between faculty and students.
15. **hasTA:** Relationship between faculty and teaching assistants.
16. **peerOf:** Relationship between students taking the same courses.
17. **registeredBy:** Relationship between courses and registered students.
18. **taughtBy:** Relationship between courses and teaching staff.
19. **teaches:** Inverse of taughtBy.

4.2 Data Properties

1. **hasAge:** Age of an individual.
2. **hasLabel:** Name or label of an individual.
3. **hasName:** Name of an individual.
4. **hasNoStudents:** Number of students associated with a faculty.
5. **hasPhonenumber:** Phone number of an individual.
6. **joinedOn:** Joining date of an individual.
7. **staffID:** Staff ID of a staff member.
8. **studentID:** Student ID of a student.

5.0 Logic

5.1 Classes and Subclasses

Entities are organized into classes and subclasses to represent their hierarchical relationships and characteristics. For example:

- Faculty is a subclass of Person, representing a specific category of individuals.
- Major and Minor are subclasses of Course, representing different types of academic courses.

5.2 Object Properties

Relationships between entities are defined using object properties, specifying domains and ranges. For example:

- Admits has a domain of Faculty and a range of Student, representing the relationship where a faculty admits a student.
- hasFaculty has a domain of University and a range of Faculty, representing the relationship where the university has faculties.

5.3 Data Properties

Data properties are used to define attributes or characteristics of entities. For example:

- hasAge is a data property with a domain of Person and a range of xsd:nonNegativeInteger, representing the age of an individual.
- hasName is a data property with a domain of Person and a range of xsd:string, representing the name of an individual.

5.4 General Axioms

General axioms impose constraints on classes or properties. For example:

- Disjointness axioms ensure that certain classes or properties are mutually exclusive. For instance, Administrative, House_keeping, and IT classes are disjoint.
- Minimum qualified cardinality restrictions ensure that certain relationships have a minimum number of instances. For example, each Faculty must have at least one associated Program

6.0 Test Queries and Their Output:

1- A query that gets all undergraduate students.

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX uni: <http://www.semanticweb.org/neema/ontologies/2024/4/university/>

SELECT ?student
WHERE {
  ?student rdf:type uni:Undergraduate .
}
```

Result:

student
Saeed
AbdulRaouf
AbdulRahman
Tasneem
Sameh

2- A query that gets all postgraduate students or TAs.

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX uni: <http://www.semanticweb.org/neema/ontologies/2024/4/university/>

SELECT ?student
WHERE {
  ?student rdf:type uni:Postgrad_TA.
}
```

Result:

student
Eman

3- A query that gets all Core Subjects.

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX uni: <http://www.semanticweb.org/neema/ontologies/2024/4/university/>

SELECT ?subject
WHERE {
  ?subject rdf:type uni:Core.
}
```

Result:

subject
Control_systems
Math1
Logic_Design
Math2

4- A query that contains at least 2 Optional Graph Patterns.

```
PREFIX uni: <http://www.semanticweb.org/neema/ontologies/2024/4/university/>

SELECT ?student ?age ?id
WHERE {
  ?student rdf:type uni:Undergraduate.
  OPTIONAL {
    ?student uni:hasAge ?age.
  }
  OPTIONAL {
    ?student uni:studentID ?id.
  }
}
```

Result:

student	age	id
Saeed	"22"^^<http://www.w3.org/2001/XMLSchema#nonN	"19P2342"@
AbdulRaouf	"23"^^<http://www.w3.org/2001/XMLSchema#nonN	"19P4442"@
AbdulRahman	"24"^^<http://www.w3.org/2001/XMLSchema#nonN	"19P1234"@
Tasneem	"23"^^<http://www.w3.org/2001/XMLSchema#nonN	"19P4152"@
Sameh	"23"^^<http://www.w3.org/2001/XMLSchema#nonN	"19P8434"@

5- A query that contains at least 2 alternatives and conjunctions:

```
PREFIX uni: <http://www.semanticweb.org/neema/ontologies/2024/4/university/>

SELECT ?object
WHERE {
 {
  ?object rdf:type uni:Undergraduate .
 }
 UNION
 {
  ?object rdf:type uni:Postgrad_TA .
 }
 UNION
 {
  ?object rdf:type uni:Faculty .
 }
 FILTER(?object != uni:Tasneem && ?object != uni:Eng_Mohsen && ?object != uni:Faculty_of_medicine)
}
```

Result:

object
Saeed
AbdulRaouf
AbdulRahman
Sameh
Eman
Faculty_of_Engineering

6- A query that contains an CONSTRUCT query form:

```
PREFIX uni: <http://www.semanticweb.org/neema/ontologies/2024/4/university/>

CONSTRUCT {
 ?prof uni:isActiveProfessor uni:true.
}
WHERE {
 ?prof rdf:type uni:Professor .
 ?prof uni:teaches ?course.
}
```

Result:

Subject	Predicate	Object
Dr_Mahmoud_Khalil	isActiveProfessor	true
Dr_Ensaf	isActiveProfessor	true

7- A query that contains an ASK query form:

```
PREFIX uni: <http://www.semanticweb.org/neema/ontologies/2024/4/university/>

ASK {
 ?student rdf:type uni:Undergraduate .
 ?course rdf:type uni:Core .
 ?student uni:enrolledIn ?course .
}
```

Result
False

8- A query that contains a DESCRIBE query form.

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX uni: <http://www.semanticweb.org/neema/ontologies/2024/4/university/>

DESCRIBE ?faculty
WHERE {
 ?faculty rdf:type uni:Faculty .
}
```

Result:

Subject	Predicate	Object
Faculty_of_Engineering	type	NamedIndividual
Faculty_of_Engineering	hasProfessor	Dr_Mahmoud_Khalil
Faculty_of_Engineering	type	NamedIndividual
Faculty_of_Engineering	hasFacility	Women_Toilet
Faculty_of_Engineering	type	NamedIndividual
Faculty_of_Engineering	hasProfessor	Dr_Ensaf
Faculty_of_Engineering	type	NamedIndividual
Faculty_of_Engineering	hasFacility	Archive_Room
Faculty_of_Engineering	type	NamedIndividual
Faculty_of_Engineering	hasStudent	Saeed
Faculty_of_Engineering	type	NamedIndividual
Faculty_of_Engineering	hasFacility	ChemistryLab
Faculty_of_Engineering	type	NamedIndividual
Faculty_of_Engineering	hasFacility	Men_Toilet
Faculty_of_Engineering	type	NamedIndividual
Faculty_of_Engineering	hasFacility	Computer_Lab
Faculty_of_Engineering	type	NamedIndividual
Faculty_of_Engineering	hasStudent	Tasneem
Faculty_of_Engineering	type	NamedIndividual
Faculty_of_Engineering	hasTA	Eman
Faculty_of_Engineering	type	NamedIndividual
Faculty_of_Engineering	Admits	Saeed
Faculty_of_Engineering	type	NamedIndividual

9- A query that gets all Elective Subjects.

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX uni: <http://www.semanticweb.org/neema/ontologies/2024/4/university/>

SELECT ?subject
WHERE {
 ?subject rdf:type uni:Elective.
}
```

Result:

subject
Deep_Learning
Data_Mining
Computer_Vision
Big_Data

10- A query that gets all Professors.

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX uni: <http://www.semanticweb.org/neema/ontologies/2024/4/university/>

SELECT ?prof
WHERE {
  ?prof rdf:type uni:Professor.
}
```

Result:

subject
Dr_Ensaf
Dr_Mahmoud_Khalil

11- A query that gets all facilities of the faculty of engineering.

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX uni: <http://www.semanticweb.org/neema/ontologies/2024/4/university/>

SELECT ?facility
WHERE {
  ?faculty rdf:type uni:Faculty;
           uni:hasFacility ?facility.
  FILTER(?faculty = uni:Faculty_of_Engineering)
}
```

Result:

facility
Women_Toilet
Archive_Room
ChemistryLab
Men_Toilet
Computer_Lab

12- A query that gets all undergraduate or postgrad students with age greater than 22.

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX uni: <http://www.semanticweb.org/neema/ontologies/2024/4/university/>

SELECT ?person

WHERE {
 {
  ?person rdf:type uni:Undergraduate;
        uni:hasAge ?age.
  FILTER(?age > 22)
 }
 UNION
 {
  ?person rdf:type uni:Postgrad_TA;
        uni:hasAge ?age.
  FILTER(?age > 22)
 }
}
```

Result:

person
AbdulRaouf
AbdulRahman
Tasneem
Sameh
Eman

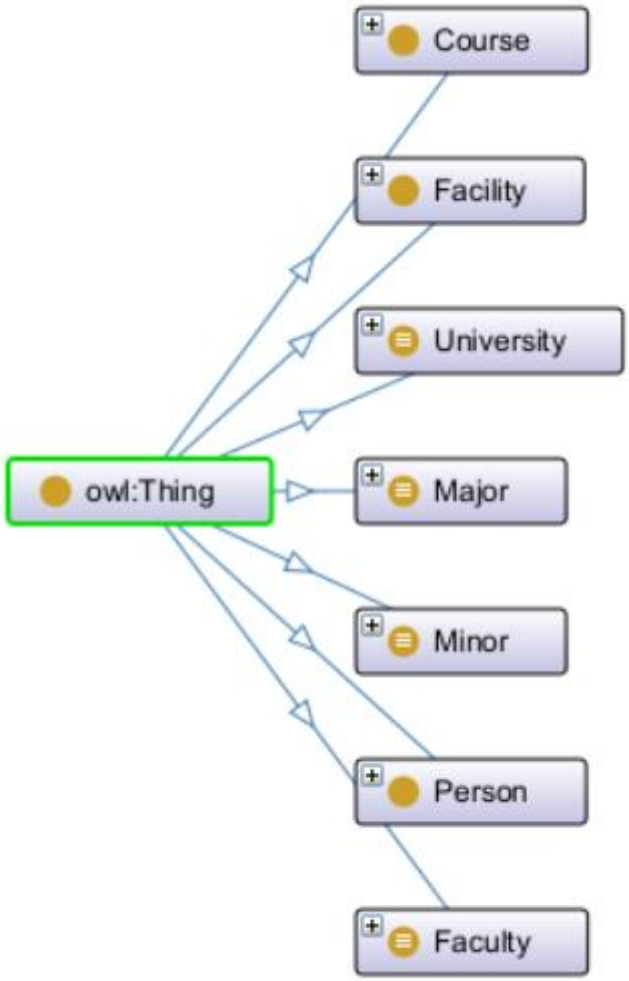
13- A query that gets all undergraduate students with a registered phone number.

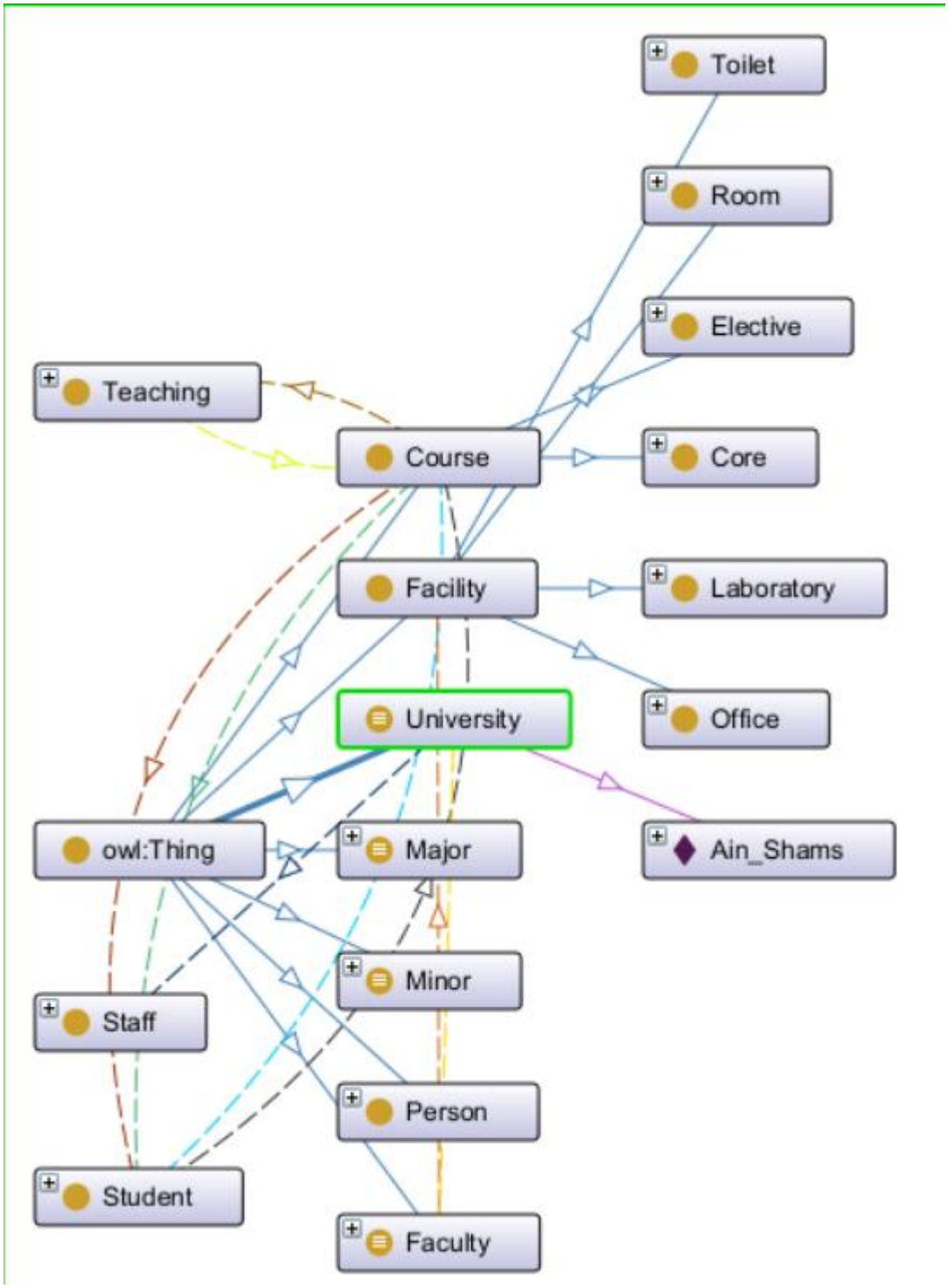
```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX uni: <http://www.semanticweb.org/neema/ontologies/2024/4/university/>

SELECT ?student

WHERE {
   ?student rdf:type uni:Undergraduate;
            uni:hasPhonenumber ?number.
}
```

Result:

student
Saeed
AbdulRaouf
AbdulRahman
Tasneem
Sameh

7.0 Visualize the Ontology:

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Elective
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Course
Core
Facility
Laboratory
University
Office
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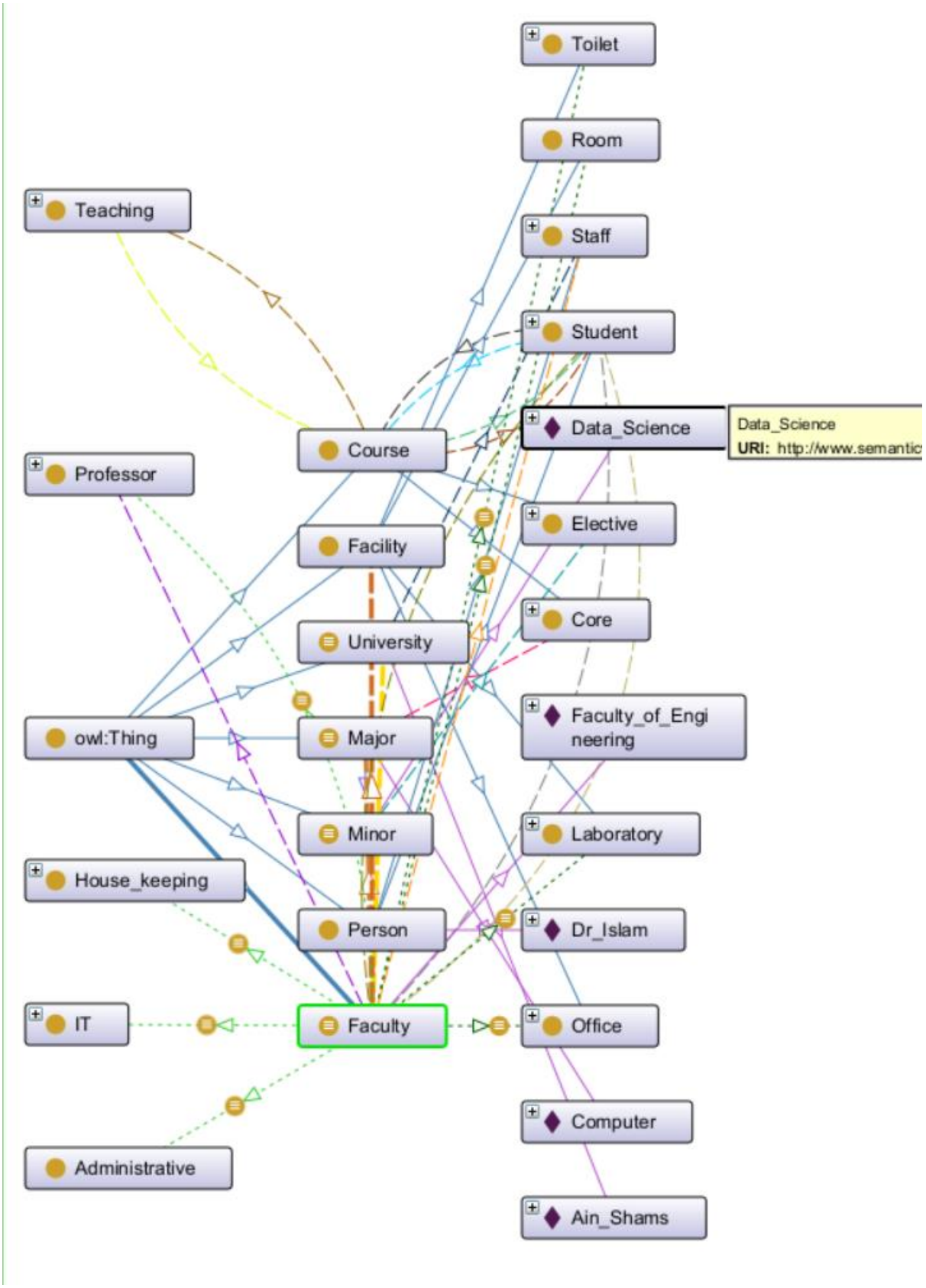
Major
Ain_Shams
Minor
Staff
Person
Student
Faculty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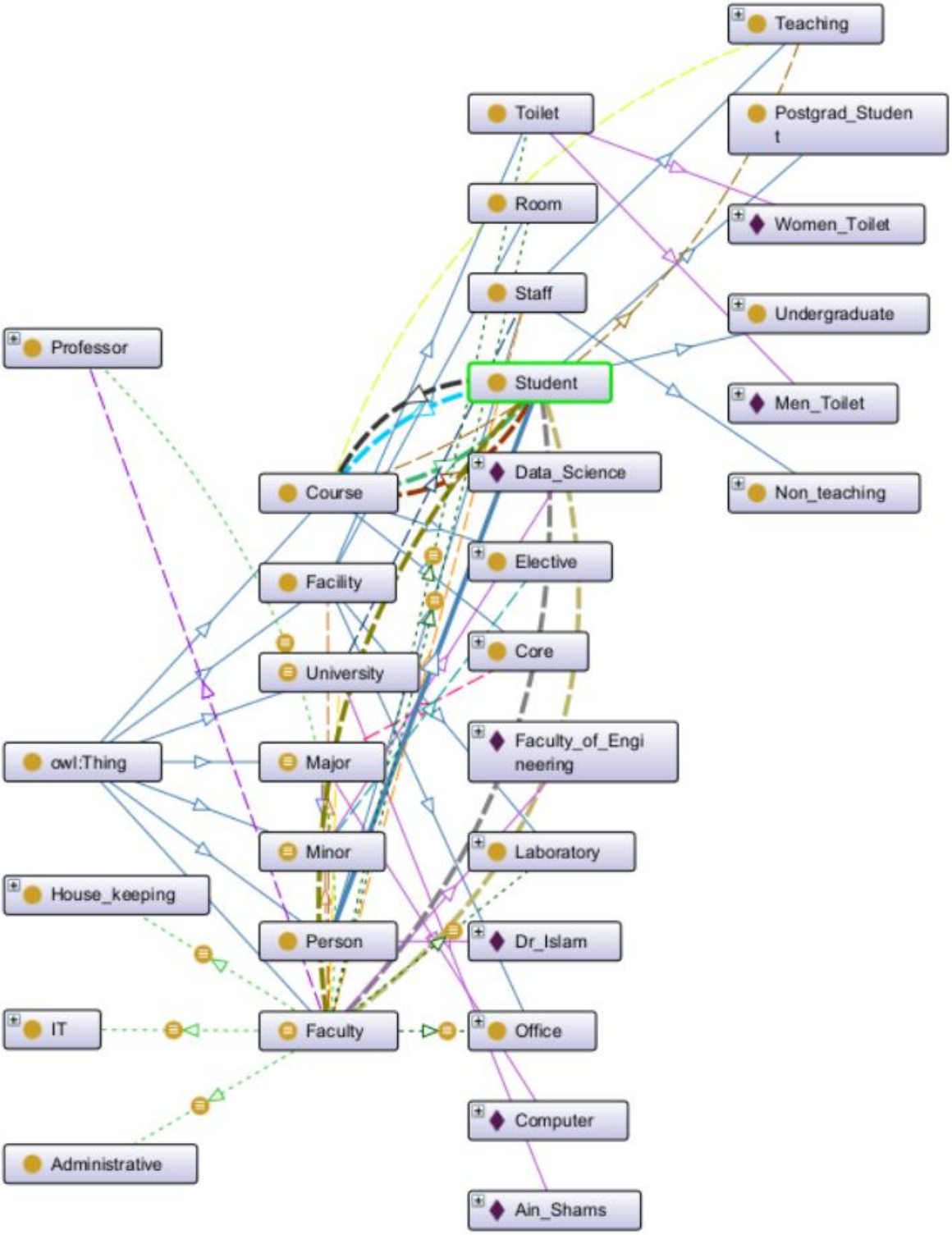
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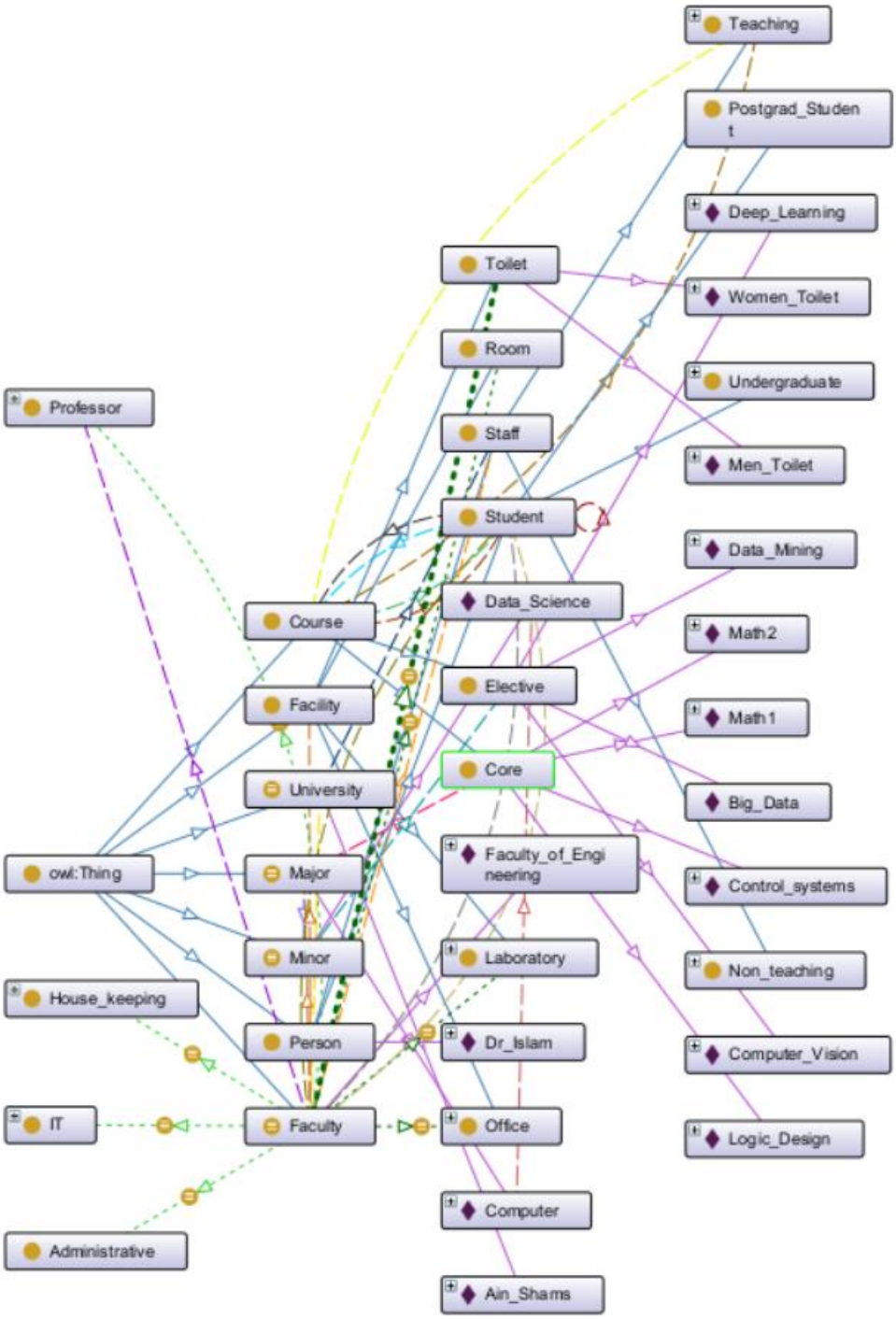
Ain_Shams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Postgrad_Student
Deep_Learning
Toilet
Women_Toilet
Room
Undergraduate
Professor
Staff
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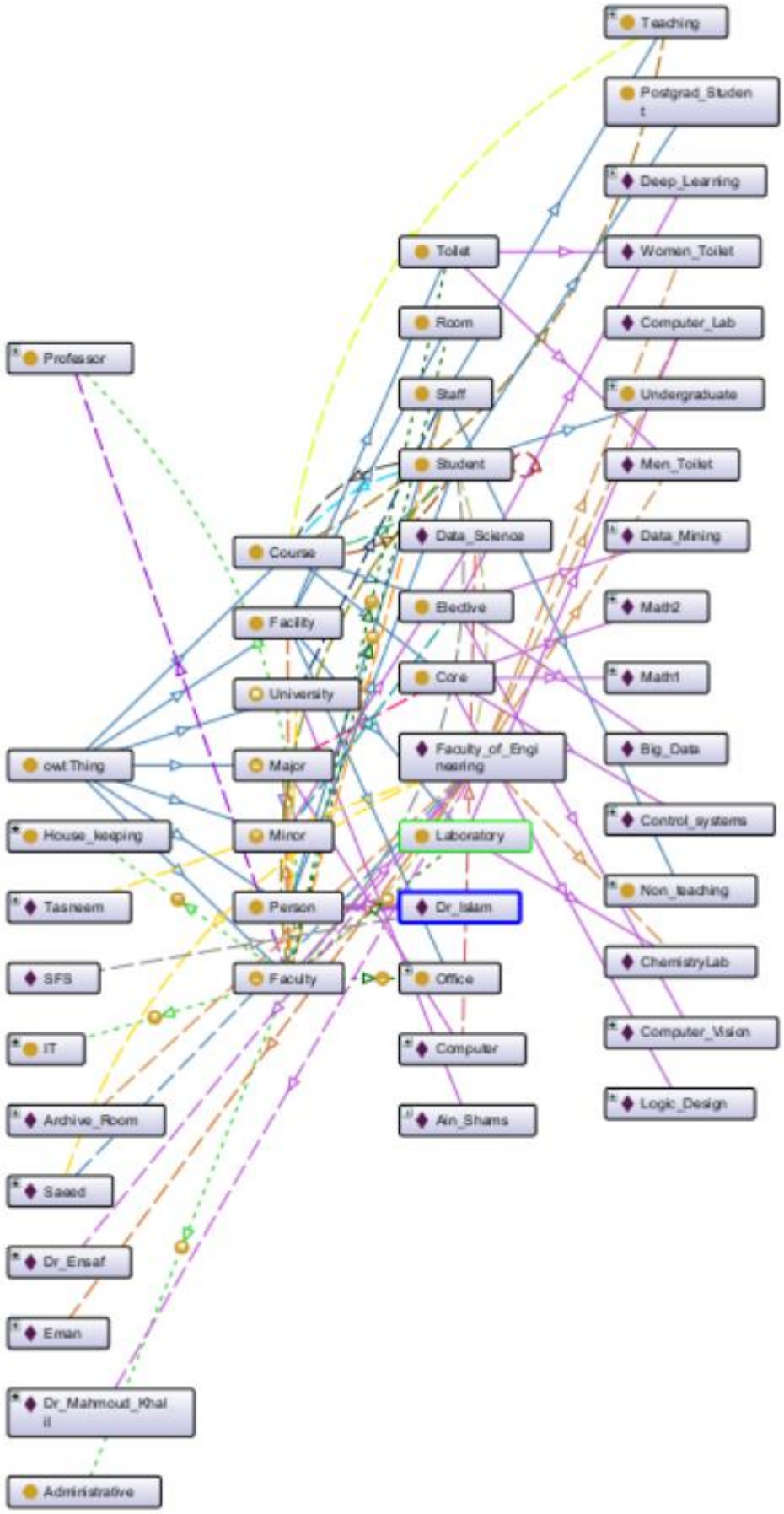
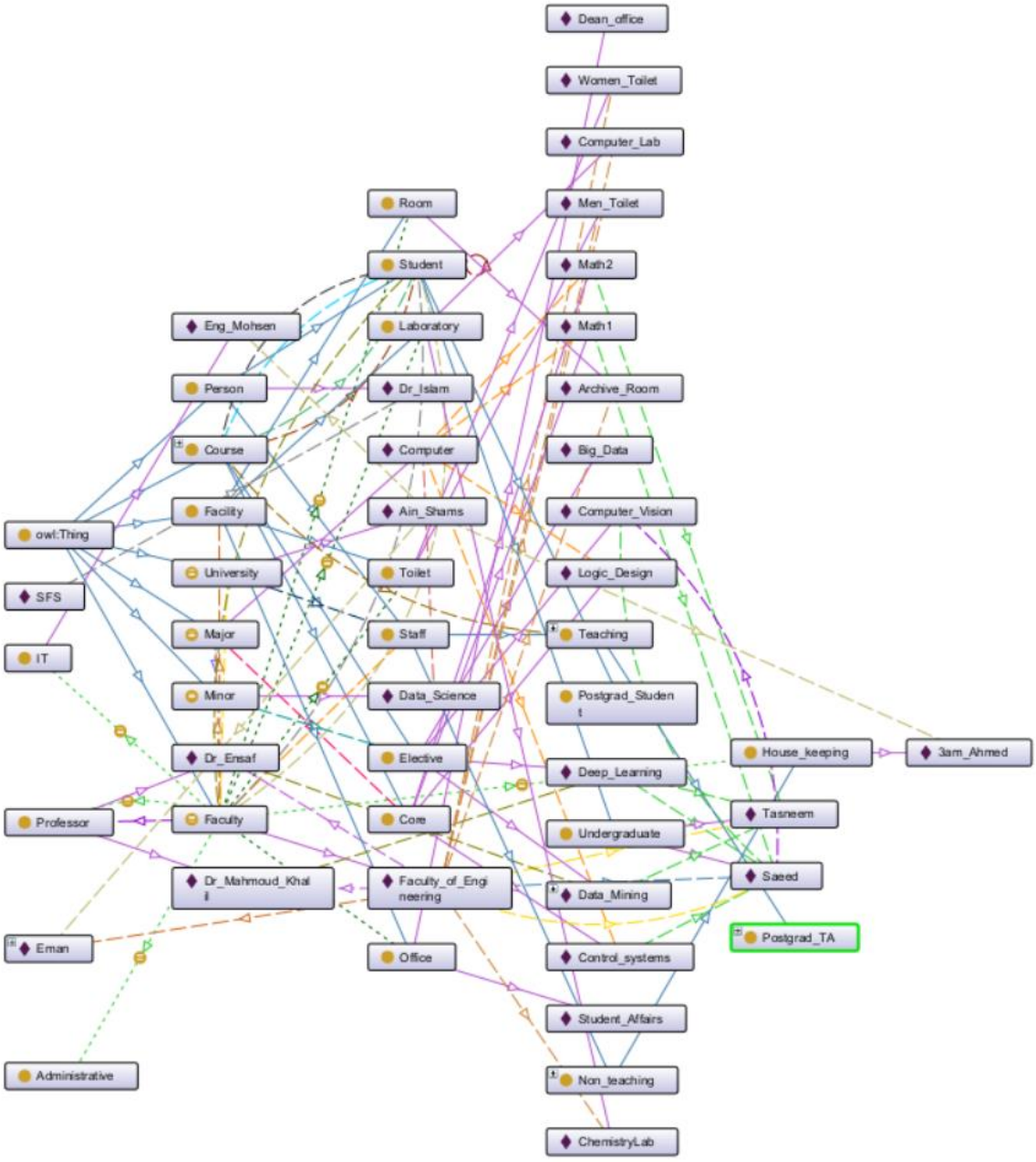
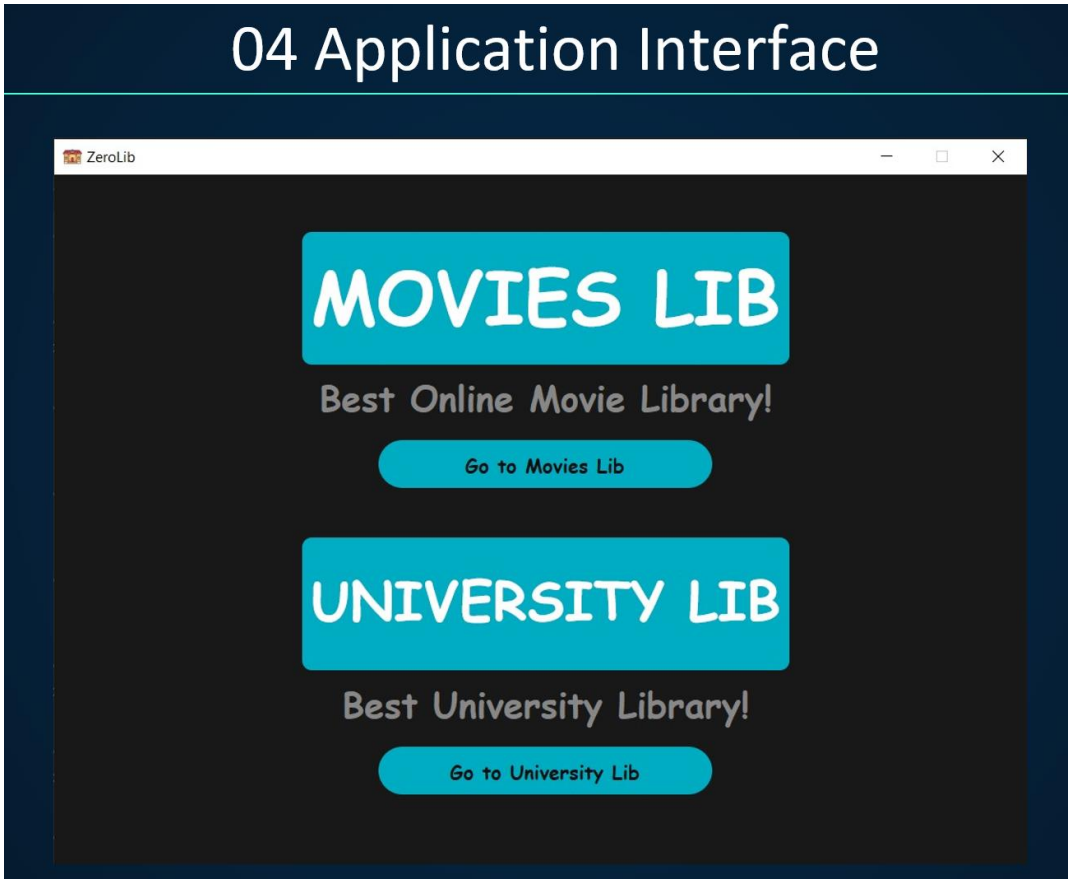
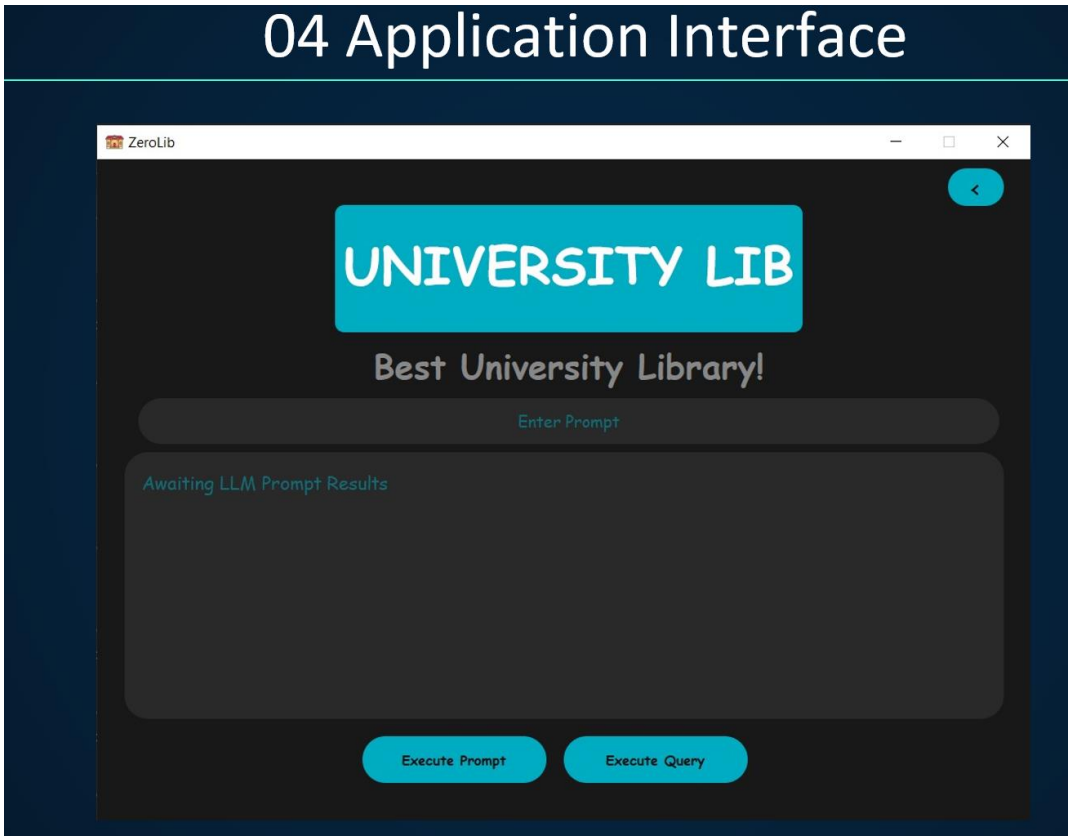
Data_Science
Course
Math2
Elective
Facility
Math1
Core
University
Big_Data
owl:Thing
Faculty_of_Engineering
Major
Control_systems
Minor
Laboratory
Non_teaching
House_keeping
Person
Dr_Islam
Computer_Vision
IT
Faculty
Office
Logic_Design
Computer
Administrative
Ain_Shams


Teaching
Postgrad_Student
Deep_Learning
Toilet
Women_Toilet
Room
Computer_Lab
Professor
Staff
Undergraduate
Student
Men_Toilet
Data_Science
Data_Mining
Course
Elective
Math2
Facility
Core
Math1
University
owl:Thing
Major
Faculty_of_Engineering
Big_Data
House_keeping
Minor
Laboratory
Control_systems
Tasneem
Person
Dr_Islam
Non_teaching
SFS
Faculty
Office
ChemistryLab
IT
Computer
Computer_Vision
Archive_Room
Ain_Shams
Logic_Design
Saeed
Dr_Ensaf
Eman
Dr_Mahmoud_Khalil
Administrative

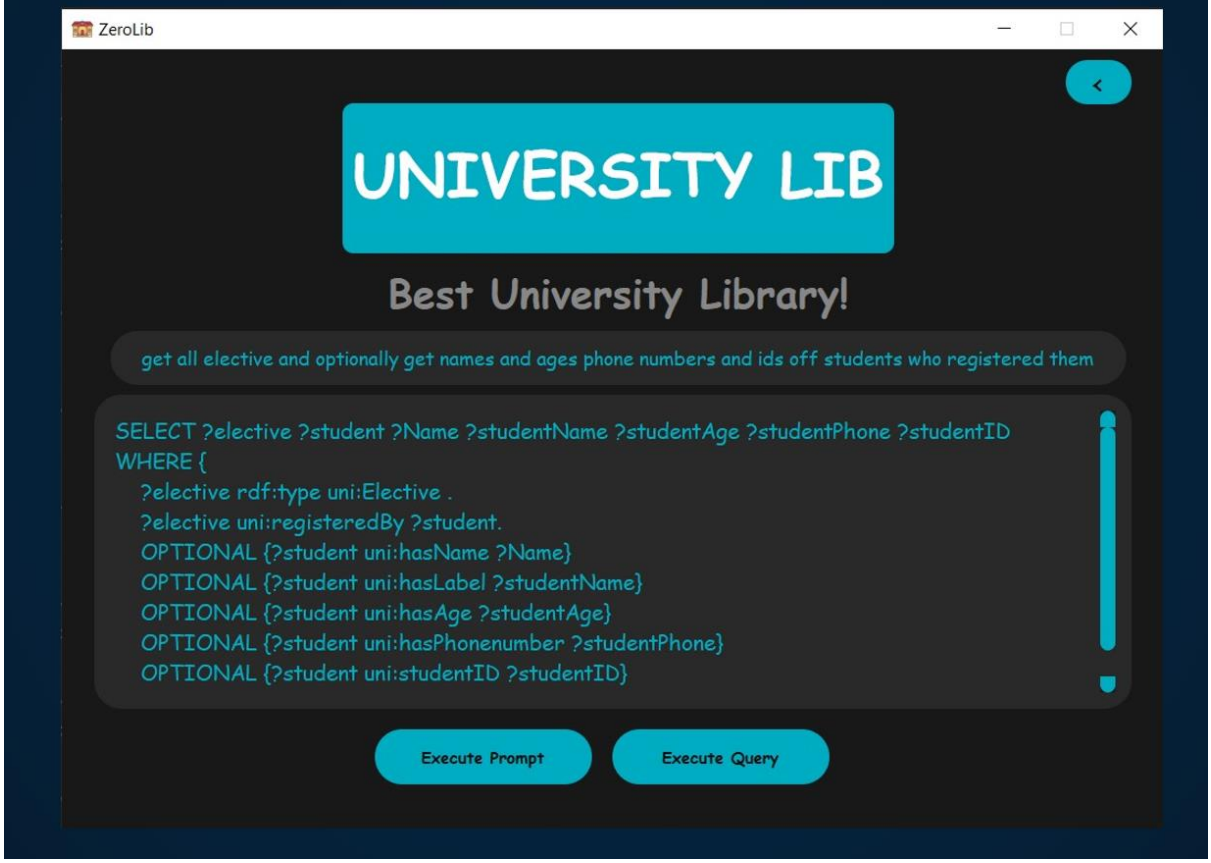

Dean_office
Women_Toilet
Computer_Lab
Room
Men_Toilet
Student
Math2
Eng_Mohsen
Laboratory
Math1
Person
Dr_Islam
Archive_Room
Course
Computer
Big_Data
Facility
Ain_Shams
Computer_Vision
owl:Thing
University
Toilet
Logic_Design
SFS
Major
Staff
Teaching
IT
Minor
Data_Science
Postgrad_Student
House_keeping
Jam_Ahmed
Dr_Ensaf
Elective
Deep_Learning
Professor
Faculty
Core
Undergraduate
Tasneem
Dr_Mahmoud_Khalil
Faculty_of_Engineering
Saeed
Data_Mining
Eman
Postgrad_TA
Office
Control_systems
Student_Affairs
Administrative
Non_teaching
ChemistryLab

8.0 Snapshots of the Interface:

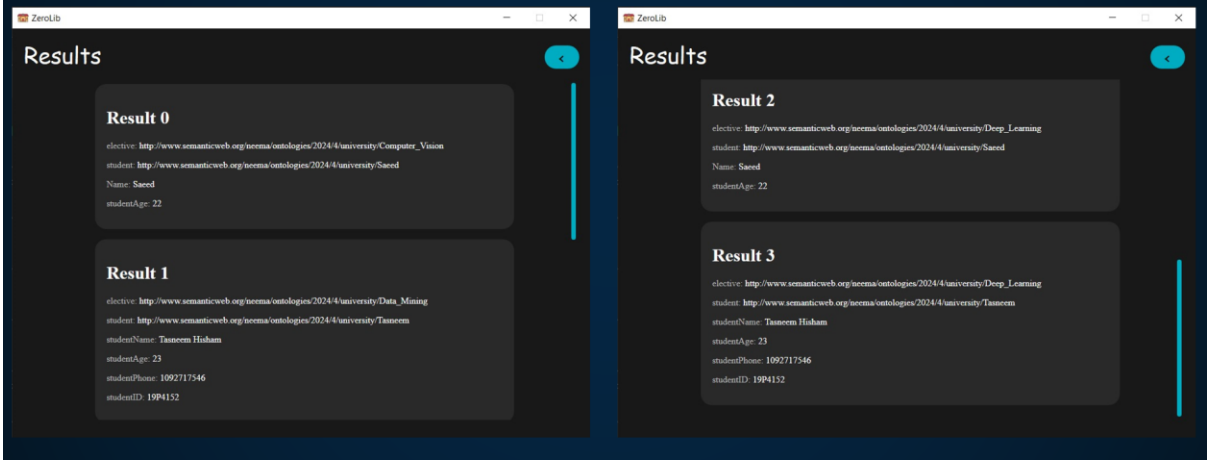




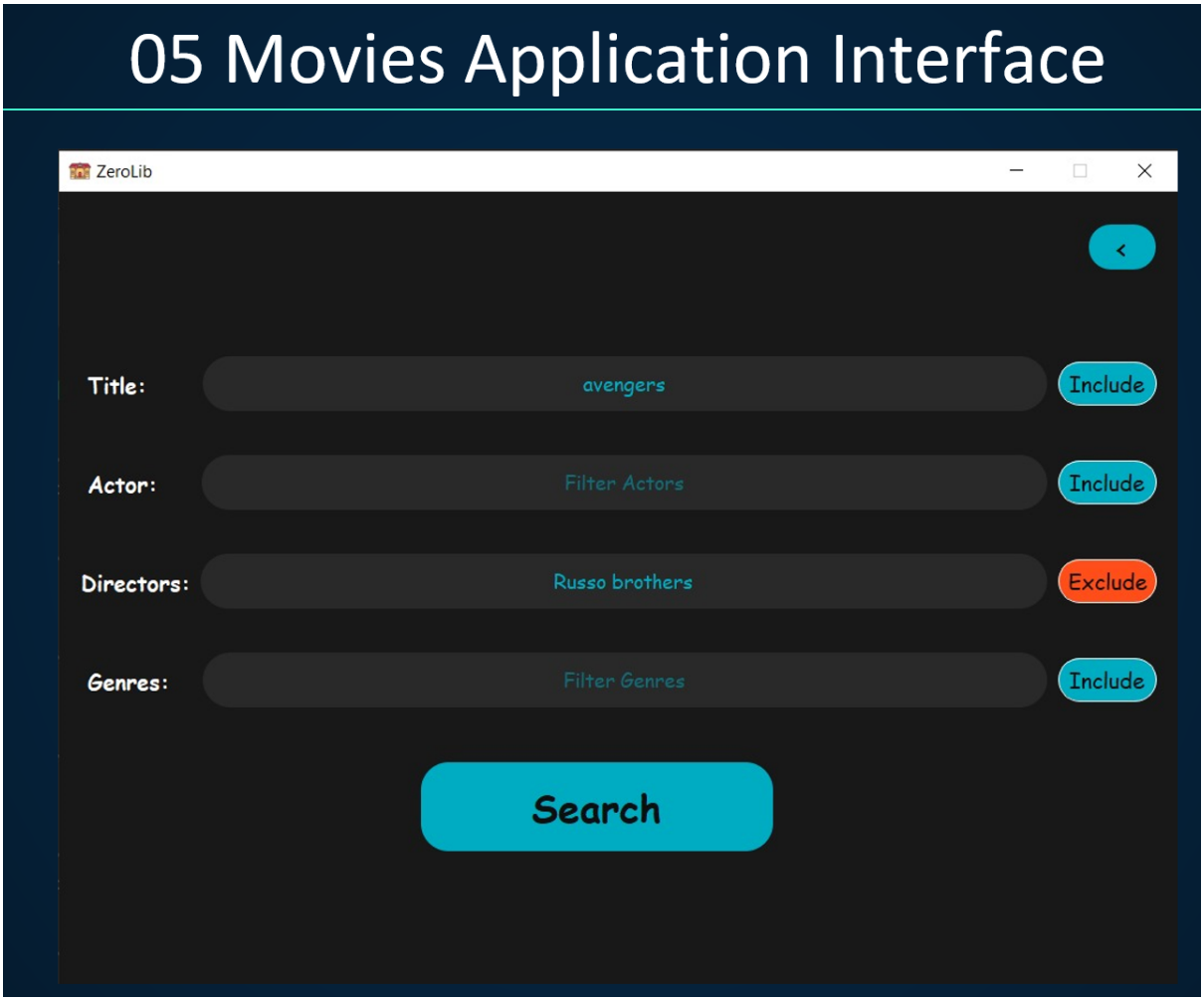
04 University Application Interface



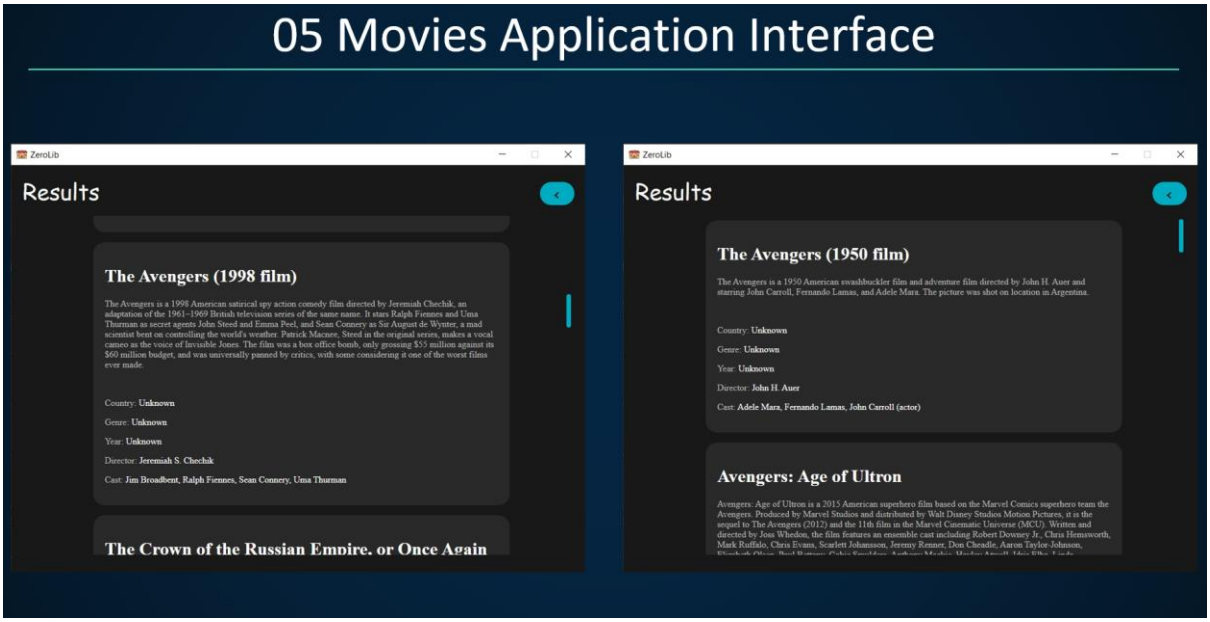
04 University Application Interface



05 Movies Application Interface

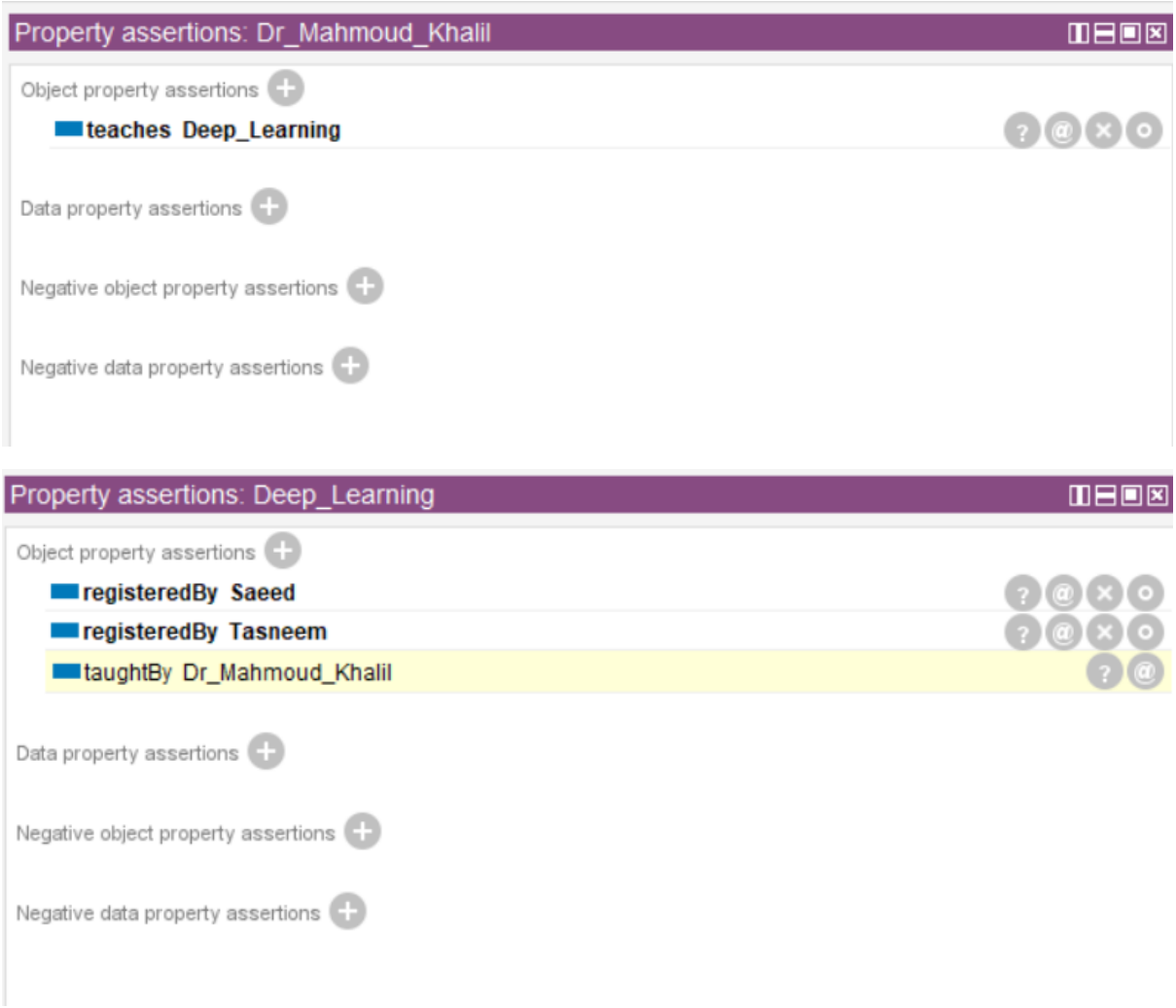


05 Movies Application Interface

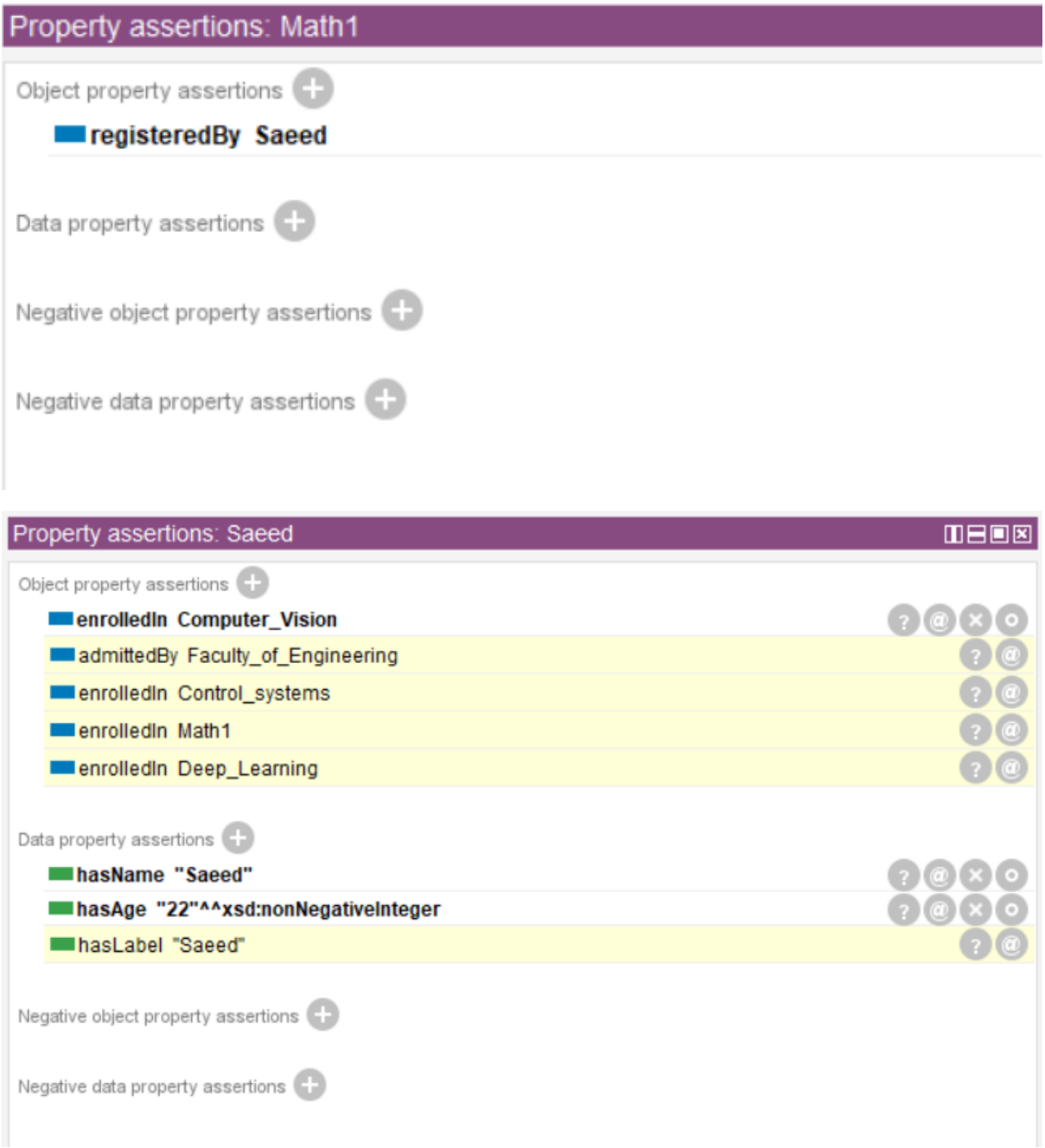


9.0 Test Cases

When we define that Dr. Mahmoud Khalil teaches deep learning, it automatically infers that deep learning is taught by Dr. Mahmoud.



When we define that math1 is registered by Saeed, it automatically infers that Saeed is enrolled in the course, and the same applies for the rest. It also infers that he is admitted by the faculty of engineering.



When the faculty of engineering has a professor or a TA, it infers that there are staff at the faculty of engineering.