Projet IA301

Knowledge and logical reasoning

COVID-19 vaccination knowledge graph

Realized by:
Amani MOKNI
Marwen BAHRI
Yoldoz TABEI
Mahdi CHEIKHROUHOU

Supervised by:
Isabelle BLOCH

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Chapter 1

Introduction

The COVID-19 pandemic is one of the most dangerous challenges this world has faced in our lifetime. It is above all a human crisis with severe health and socio-economic consequences.
Now that COVID-19 vaccines have reached billions of people worldwide, the evidence is overwhelming that no matter which one you take, the vaccines offer life-saving protection against a disease that has killed millions. The pandemic is far from over, and they are our best bet of staying safe.
In this project we will define an ontology that will help us retrieve informations about the progress of the vaccination against the COVID-19.

Project link : https://github.com/Mtaylorr/IA301-ONTOLOGY-SYMBOLIC_AI

Chapter 2

The ontology

2.1 Description

In this section we will define the classes that we used to construct the knowledge graph :

- Person : This class represents the people
- AgeGroup : This class represents the age group of a person
  - Kid
  - Juvenile
  - Teenager
  - Adult
  - Elderly
- Gender : This class represents the gender of a person
  - Male
  - Female
- Job : This class indicates if the job of a person is a medical worker or not.
  - MedicalWorker
  - Other
- Region : This class represents the status of the area in wich the person resides.
  - Green
  - Orange
  - Red
- MedicalCondition : This class represents the medical conditions that may aggravate the risks of a severe illness from COVID-19.

  - Cancer
  - CKD : chronic kidney disease
  - CLiverD : Chronic liver disease
  - ClungD : chronic lung disease
  - Diabetes
  - HIV

- Vaccin : This class represents the different types of vaccines (most used ones)
  - AstraZeneca
  - Johnson_and_johnson
  - Moderna
  - Pfizer
  - Sputnik

- VaccinProgress : This class represents the status of a vaccination of a given person. A person may have had a single shot of a vaccin , or completed the vaccination or may didn't even start doing the vaccination.
  - FullyVaccinated
  - NotVaccinated
  - PartiallyVaccinated

- WillingessToVaccinate : This class represents the readiness of a person to take the vaccin.
  - Against
  - For
  - Neutral

2.2 Representation of the ontology using protege

2.2.1 Class Hierarchy

The ontolgy contains 9 main classes where each one contains its own subclasses as shown in the figure below :

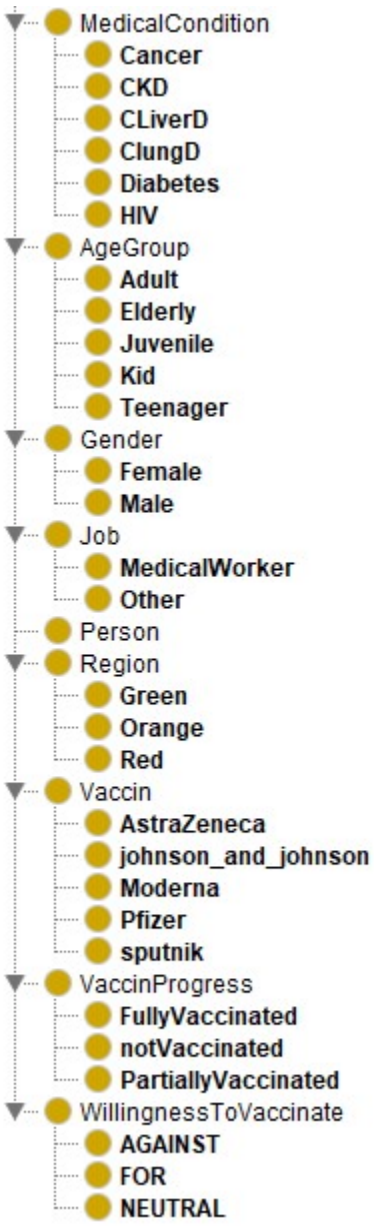

Figure 2.1: Class Hierarchy

2.2.2 Metrics

The ontology metrics view displays entity and axiom counts for the axioms in the active ontology and its imports closure which is represented below :

Metrics

Axiom	**188**
Logical axiom count	**109**
Declaration axioms count	**79**
Class count	**38**
Object property count	**10**
Data property count	0
Individual count	**32**
Annotation Property count	0

Class axioms

SubClassOf	**29**
EquivalentClasses	0
DisjointClasses	**7**
GCI count	0
Hidden GCI Count	0

Object property axioms

SubObjectPropertyOf	**9**
EquivalentObjectProperties	0
InverseObjectProperties	0
DisjointObjectProperties	0
FunctionalObjectProperty	0
InverseFunctionalObjectProperty	0
TransitiveObjectProperty	0
SymmetricObjectProperty	0
AsymmetricObjectProperty	0
ReflexiveObjectProperty	0
IrrefexiveObjectProperty	0
ObjectPropertyDomain	**8**
ObjectPropertyRange	**8**
SubPropertyChainOf	0

Figure 2.2: Ontology metrics 1

Individual axioms

ClassAssertion	32
ObjectPropertyAssertion	16
DataPropertyAssertion	0
NegativeObjectPropertyAssertion	0
NegativeDataPropertyAssertion	0
SameIndividual	0
DifferentIndividuals	0

Figure 2.3: Ontology metrics 2

2.2.3 Object Properties

Object properties represents relationships between individuals.

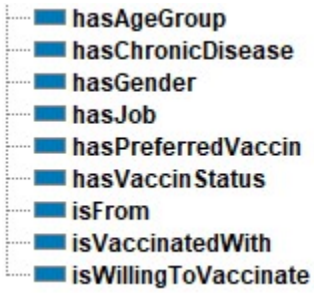

Figure 2.4: Object properties

2.2.4 Individuals

The individuals are some instances of the classes that we defined.

Figure 2.5: Individuals

2.2.5 Inferred ontologies

We can see that the class hiearchy didn't change in the inferred mode after starting the reasoner HermiT.

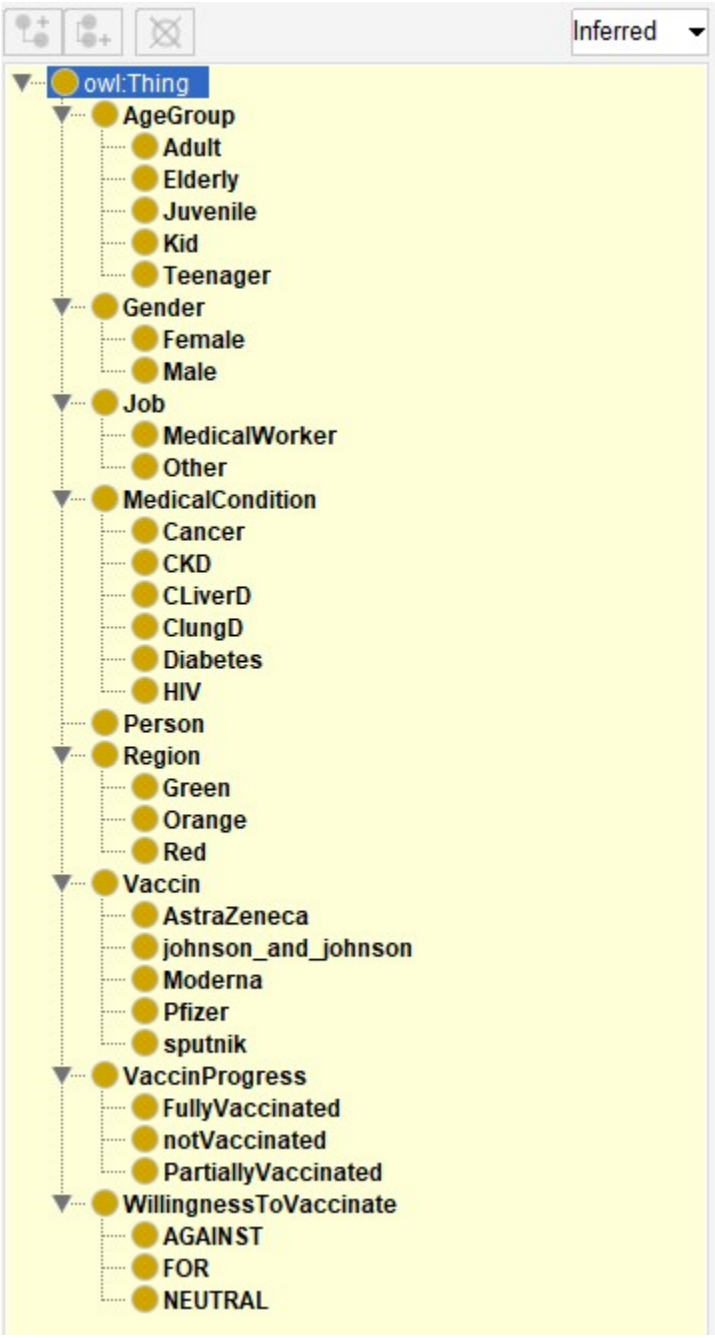

Figure 2.6: Inferred ontologies

To verify our model , we tried some DL queries :

Figure 2.7: First query

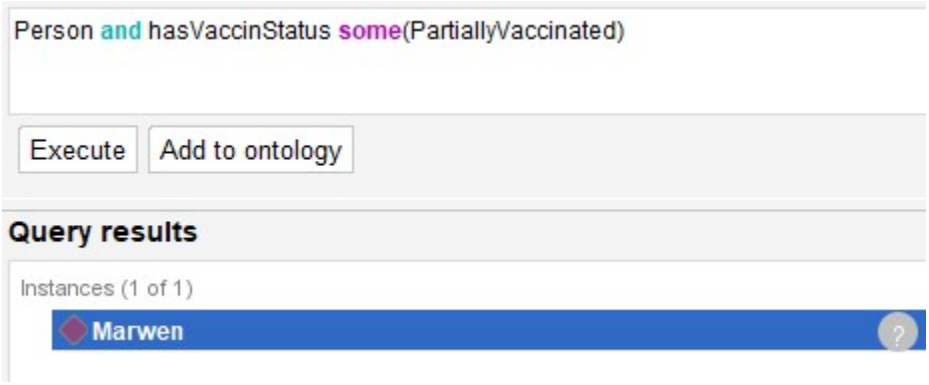

Figure 2.8: Second query

2.2.6 Graph-like representation of all the classes and their interactions

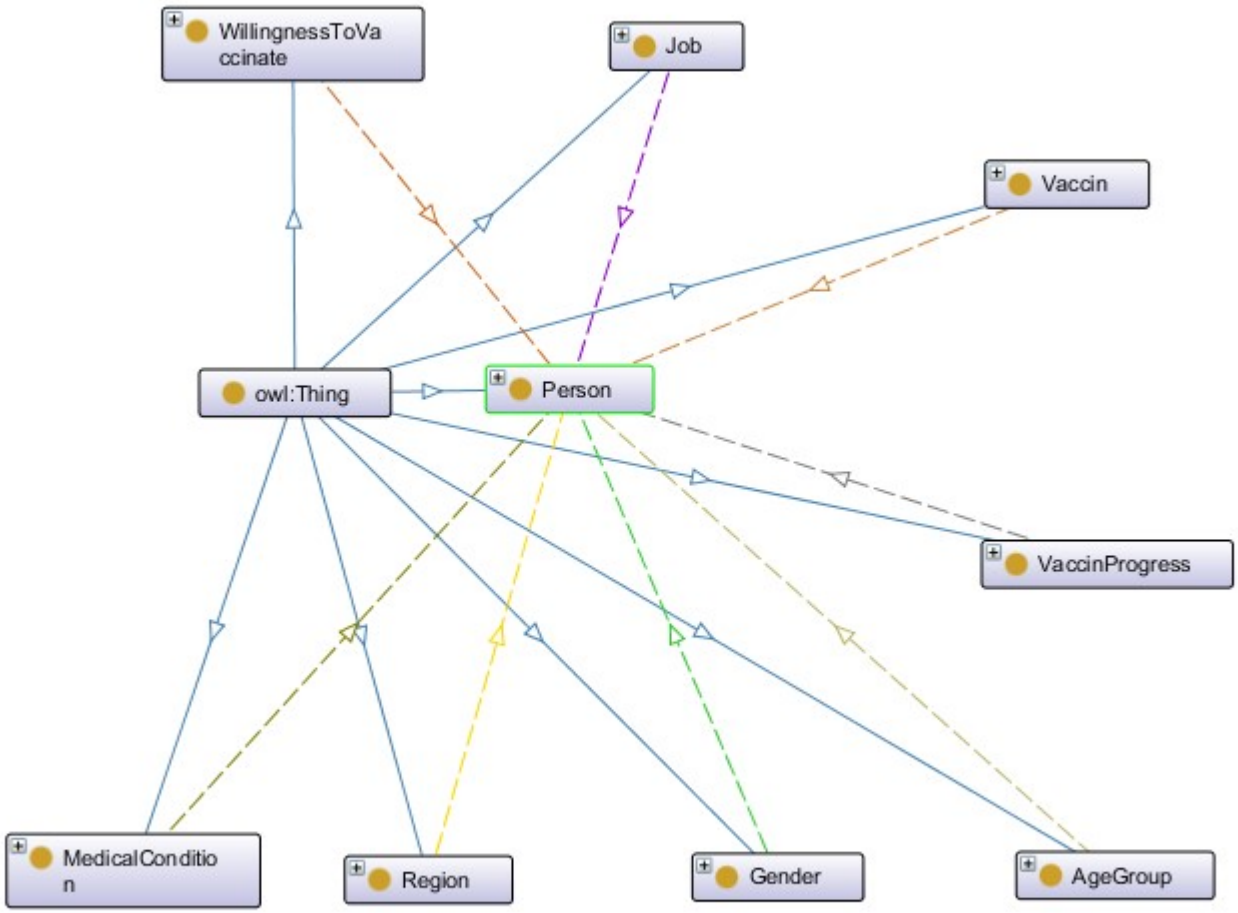

Figure 2.9: Classes and interactions

Chapter 3

Justification of the design

To create this graph, we asked ourselves what are the necessary information you would like to know about a group of people in order to understand the status of vaccinations and therefore be able to plan for the appropriate future actions you have to take. Each class provides us with a valuable information. For instance, we would like to know if a given individual is a medical worker because he is in direct contact with patients and must get the vaccination. Another example is the *willingness to vaccinate*, this is a useful information since it can tell us if we need to organize an awareness campaign if we have low readiness to vaccinate or provide more vaccine shots needed.

Chapter 4

Conclusion

Scientific and technological knowledge and resources have never been greater and have been leveraged globally to perform COVID-19 vaccination research at warp speed.

The ontology we have created provides a powerful method of data integration and sharing that allows physicians, researchers, and public health organizations to respond rapidly and efficiently to current and future public health crises.

Moreover, it allows data about novel diseases to be easily compared, along multiple dimensions, with data represented by existing disease ontologies. As we see, logically well-designed and structured ontologies, is a powerful data sharing tool. But to be effective, ontologies must be designed in a coordinated fashion.