IA301 - Logics and Symbolic AI
TP

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1 OWL with Protege

1.1 Simple Ontology (Preliminary Case)

We explore the tool using the given example.
Let's answer the few questions asked at the end of this part.

— What do we observe when we check the inferred classes ?

Answer : The inferred classes are the same as the asserted classes. This means that there are no additional logical consequences or inferences made by the reasoner beyond what has already been explicitly asserted in the ontology. This indicates that the ontology is consistent, and the asserted hierarchy or relationships between classes are correctly modeled according to the ontology's logical structure.

— Some DL queries examples and results.

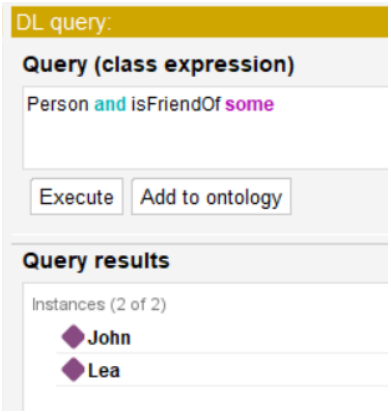

FIGURE 1 – DL query : Persons who have friends

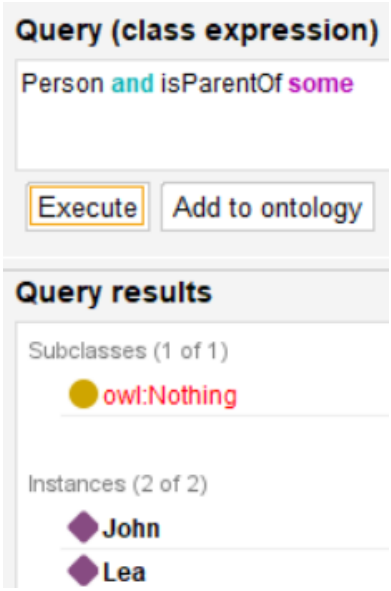

FIGURE 2 – Persons who are Parents

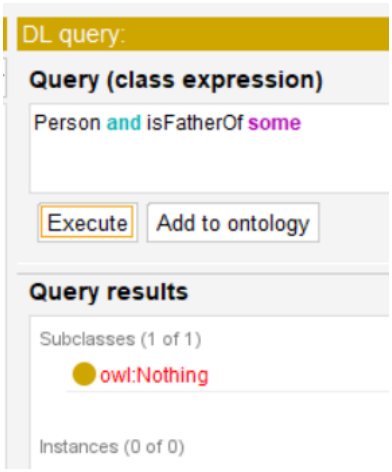

FIGURE 3 – Persons who are Fathers : Issue there

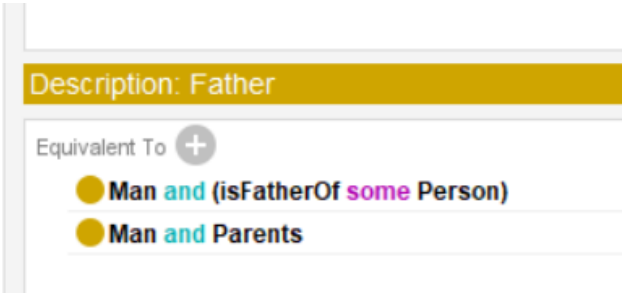

FIGURE 4 – Adding two axiom to the Father Class

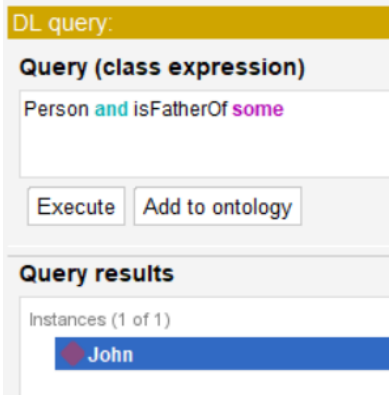

FIGURE 5 – This enabled the reasoner to infer that John is a Father

FIGURE 6 – All Images Displayed in Two Rows with Harmonized Widths

1.2 Ontology of Ecosystem Interactions and Resource Consumption

To explore the logical relationships related to the consumption of natural resources and the environment, the theme chosen for the ontology was the model of an ecosystem, with a focus on the relationships and interactions among organisms (such as animals, plants, and microorganisms), their environments, and the resources they require.

Overall, our model presents three main classes that interact with each other : the classes of **Organisms**, **Resources**, and **Environments**. Organisms are further divided into three main subclasses : Animals, Plants, and Microorganisms. These organisms inhabit specific Environments and consume a set of natural resources provided by those environments.

Additionally, important relationships can be inferred from this model, with the main ones being :

— The relationship of coexistence, where two organisms cohabit the same environment without one being a predator of the other ;
— Relationships involving the consumption of certain natural resources based on the characteristics of the organisms and the environment in which they live ;
— Relationships concerning the food chain within the ecosystem, based on the type of food/energy source required by the organism along with characteristics of the environment.

The following image illustrates the ontology diagram that was implemented in the Protege software.

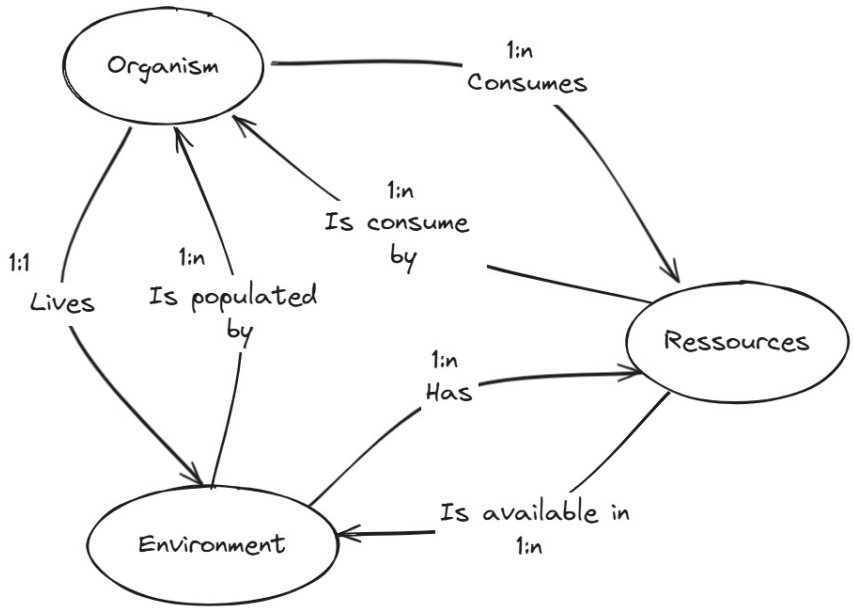

FIGURE 7 – Ontology diagram

In Figure 7, there is a cardinality relation above the arrows. These relate m individuals from the source category with n individuals from the target category. For example, the "Consumes" relation going from Organism to Resource indicates that 1 individual can consume n resources. Conversely, its symmetric relation, "Is consumed by," indicates that 1 resource can be consumed by n organisms.

1.3 Protege implementation

The following describes the classes and subclasses used to create the ontology in Protege.

- **Classes** (that are subclasses of owl :Thing) :
  - Organism ;
  - Environment ;
  - resource.
- **Subclasses** :
  - Animal, Plant and Microorganism as subclasses of Organim (all mutually disjoint from each other) ;
  - Herbivore and Carnivore as subclasses of Animals (they are both disjoint) ;
  - Bryophytes, Pteridophytes, Gymnosperms, Angiosperms as subclasses of Plants (all mutually disjoint from each other).

Regarding the Class properties, we have the following data and object properties :

- **Data properties :**
  - weight with domain Animal and range xsd :decimal ;
  - produceFruit with domain Plant and range xsd.bool. This propertie can be inferred in two ways : it will be true if this plant is eaten by an animal or if it's an angiosperm.
- **Object properties :**
  - eat with domain Animal and range Organism ;
  - livesAt with domain Organism and range Environment ;
  - consumeTheresource with domain Organism and range resource ;
  - isEatenBy with domain Organism and range Animal (is the inverse property eat) ;
  - isOccupiedBy with domain Environment and range Organism (is the inverse of livesAt) ;
  - hasTheResource with domain Environment and range resource ;
  - isAvailableIn with domain Resource and range Environment (is the inverse property hasTheResource) ;
  - canBeFoundOnTheGround with domain Resource and range Environment (meaning if a certain resource can or not be found on the ground, or if it is a gas) ;
  - coExistWith with domain Organism and range Organism. This property is symmetric. In addition, this property is different if both organisms are animals/plants or if they are both microorganisms :
    1. A and B are animals/plants : A coexists with B means that A and B lives at the same environment (livesAt(A) == livesAt(B)) **and** they do not share neither the relation A isEatenBy B nor B isEatenBy A ;
    2. A and B are both microorganisms : A coexists with B means that A and B lives at the same environment (livesAt(A) == livesAt(B)) **and** they do not consume the same resource through the relation consumeTheResource ;
    3. A is an animal or a plant and B is a microorganism : they will always coexist if the live in the same environment through the relation livesAt.