

## Semantic Web Exam – 5 February 2020

### Instructions for the submission of the solution

The candidate has to submit two files: (i) one file containing the ontology in Turtle format, with extension .ttl or .owl; (ii) one file in PDF format, containing the answers to each question starting from Q9. The solution must be submitted via the Moodle of the course no later than Monday 10 February 2020 at 12:00 (noon) Italian time. Any file received after that time will not be considered valid for the exam.

### Exercise

The fundamental concepts in an application domain related to an Italian research organisation are: employees, institutes, laboratories and research groups. Some of the facts that characterise this domain can be stated as follows:

1. An **employee** is a **person** who **has** exactly one **contract** with the **research organisation**.
2. An employee can be a **researcher**, a **technologist** or an **office worker**.
3. A researcher can be a **young researcher**, a **senior researcher** or a **director**.
4. Each employee **has** a **unique ID** (an integer).
5. A research organisation has three types of subparts: **institute**, **laboratory** and **research group**. The research organisation **consists of** more than one **institute**, each institute **consists of** more than one **laboratory** and each laboratory **consists of** at least one **research group**.
6. Each institute, each laboratory and each research group **have** exactly one **name** (a string).
7. Each employee **is member of** exactly one institute.
8. Each researcher or technologist is member of exactly one laboratory and one research group.
9. Each institute **has** one or more **buildings**. Each building **has** exactly one **location**. Each building **contains** more than one **office**. A building can also contain a **meeting room**.
10. Each employee **has** exactly one **office**. Each office **hosts** one or more employees.
11. Each office **is identified by an ID** (a string).
12. ~~Research organisation, employee, institute, laboratory, research group, building, location and office are pairwise disjoint concepts.~~

The candidate must express all the above statements in an OWL 2 DL ontology, using the RDF Turtle notation. In particular, the ontology must:

- Q1. ~~Declare the required **classes**, providing for each class a textual label and a concise textual description of the intension of the class, using the appropriate annotation properties from the RDF Schema vocabulary~~
- Q2. ~~Provide the sub class axioms defining the class taxonomy~~
- Q3. ~~Declare the required **object properties**, providing for each property:~~
  - Q3.1. ~~a textual label, using the appropriate annotation property from the RDFS vocabulary~~
  - Q3.2. ~~a textual description of the intension of the property, using the appropriate annotation property from the RDFS vocabulary~~
  - Q3.3. ~~one axiom defining the domain of the property~~
  - Q3.4. ~~one axiom defining the range of the property~~
  - Q3.5. ~~one axiom defining the inverse of the property~~
  - Q3.6. ~~any additional axioms expressing disjointness of the property with other object properties, and the property characteristics.~~
- Q4. ~~Provide the sub property axioms defining the object property taxonomy~~
- Q5. ~~Declare the required **data properties**, providing:~~
  - Q5.1. ~~a textual label, using the appropriate annotation property from the RDFS vocabulary~~
  - Q5.2. ~~a textual description of the intension of the property, using the appropriate annotation property from the RDFS vocabulary~~
  - Q5.3. ~~one axiom defining the domain of the property~~

~~Q5.4. one axiom defining the range of the property~~

~~Q5.5. any additional axioms expressing disjointness of the property with other data properties, and whether the property is functional.~~

~~Q6. Define the axioms necessary for expressing any statement in 1 to 12 that has not already been expressed.~~

~~Q7. Populate the ontology with at least one individual for each class, and at least one assertion for each property.~~

In addition, the candidate must:

~~Q8. Identify two different assertions that would make the ontology inconsistent.~~

~~Q9. Define the complex role inclusion axiom capturing the fact that if an employee has an office that is contained in a building that is assigned to an institute that is part of a research organisation, then the employee has a contract with that research organisation.~~

~~Q10. Verify and explain whether or not the created ontology (including the complex role inclusion axiom defined in Q9) satisfies the global restrictions on the axioms of an OWL 2 DL ontology.~~

~~Q11. Write the following queries in SPARQL:~~

~~Q11.1. Find all the offices that host at least one technologist and order the results by office ID.~~

~~Q11.2. Find all the young researchers with ID lower than 15000 who are members of an institute named "ISTI".~~

~~Q11.3. Among all laboratories in the research organisation ordered by name, find only the names of the two laboratories starting from the third result.~~

~~Q11.4. Find all the research groups that have a total number of employees greater than 2.~~

~~Q11.5. Find all the buildings, their offices, and optionally their meeting rooms.~~

~~Q12. Suppose that you want to model the fact that a young researcher is a researcher who is not a senior researcher and not a director. What axiom would you use to describe this fact?~~