# UE07: OWL Reasoning

Semantic AI 2023, JKU

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Your tasks:

* Read and understand the given OWL ontologies.
* Do the OWL reasoning in your head and indicate the entailments in the given tables.
* You may use Protégé to check your reasoning (see 06-Intro-OWL).

## Part I: Instance Checking (8 points)

Given are the following OWL ontologies.

For each individual derive

* of which classes it is definitely a member, i.e., that individual is a member of that class in every possible world (mark with "+"),
* of which classes it is definitely not a member, i.e., there is no possible world in which that individual is a member of that class (mark with "-"),
* and of which classes it is possibly a member, i.e., there is at least one possible world in which that individual is a member of that class and at least one possible world in which that individual is not a member of that class (mark with "?" or leave empty).

Task 1

Class: A

Class: B

Class: C

EquivalentTo: A or B

Class: D

EquivalentTo: C and (not (B))

Individual: o1

Types: A

Individual: o2

Types: B

Individual: o3

Types: C

Individual: o4

Types: D

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | A | B | C | D |
| o1 | + | ? | ? | ? |
| o2 | ? | + | ? | - |
| o3 | ? | ? | + | ? |
| o4 | ? | - | + | + |

Task 2

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Individual: o1  Facts: p1 o2  Types: C  Individual: o2  Types: C  ObjectProperty: p1  Characteristics: Symmetric  Class: C1  EquivalentTo: p1 some C  Class: C2  SubclassOf: p1 some C  Class: C3  EquivalentTo: p1 only C | |  |  |  |  | | --- | --- | --- | --- | |  | C1 | C2 | C3 | | o1 | + | ? | - | | o2 | + | ? | - | |

Task 3

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Individual: o1  Types: C1  Class: C1  Class: C2  EquivalentTo: C1  SubclassOf: C3  Class: C3  SubclassOf: C4  Class: C4  Class: C5  SubclassOf: C1  Class: C6  DisjointWith: C3 | |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | |  | C1 | C2 | C3 | C4 | C5 | C6 | | o1 | + | + | + | + | ? | - | |

Task 4

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Individual: o1  Facts: p1 o2, p1 o3  Individual: o2  Types: C1  Individual: o3  Types: C2  ObjectProperty: p1  InverseOf: p2  ObjectProperty: p2  Characteristics: InverseFunctional | |  |  |  | | --- | --- | --- | |  | C1 | C2 | | o1 | + | + | | o2 | + | ? | | o3 | ? | + | |

Task 5

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Class: A  Class: B  Class: C  EquivalentTo: A or B  Class: D  EquivalentTo: C and (not (B))  Individual: o1  Types: A  Individual: o2  Types: B  Individual: o3  Types: C  Individual: o4  Types: D | |  |  |  |  |  | | --- | --- | --- | --- | --- | |  | A | B | C | D | | o1 | + | ? | ? | ? | | o2 | ? | + | ? | - | | o3 | ? | ? | + | ? | | o4 | ? | - | + | + | |

Task 6

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Class: PERSON  EquivalentTo: HUMAN  Class: ANIMAL  Class: DOG  SubClassOf:ANIMAL  DisjointWith: OLDMAN  Class: HUMAN  EquivalentTo: PERSON  SubClassOf: ANIMAL  Class: OLDMAN  SubClassOf: PERSON  DisjointWith: DOG  Class: COLLIE  SubClassOf: DOG  Individual: flipper  Types: ANIMAL  Individual: rex  Types: DOG  Individual: mary  Types: HUMAN  Individual: john  Types: PERSON  Individual: jim  Types: OLDMAN  Individual: lassie  Types: COLLIE | |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | |  | PERSON | ANIMAL | DOG | HUMAN | OLDMAN | COLLIE | | FLIPPER | ? | + | ? | ? | ? | ? | | REX | ? | + | + | ? | - | ? | | MARY | + | + | ? | + | ? | ? | | JOHN | + | + | ? | + | ? | ? | | JIM | + | + | - | + | + | - | | LASSIE | ? | + | + | ? | - | + | |

Task 7

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Individual: o1  Types: C  Individual: o2  Facts: p o1  Types: C  Individual: o3  Types: C1  Individual: o4  Facts: p o1, p o5  Individual: o5  Types: not C, p exactly 0  Class: C  Class: C1  SubclassOf: p some C  Class: C2  EquivalentTo: p some C  Class: C3  EquivalentTo: p only C | |  |  |  |  |  | | --- | --- | --- | --- | --- | |  | C | C1 | C2 | C3 | | o1 | + | ? | ? | ? | | o2 | + | ? | + | - | | o3 | ? | + | ? | ? | | o4 | ? | ? | + | - | | o5 | - | - | - | - | |

Task 8

Class: Woman  
Class: Teacher  
Class: Artist  
Class: JohnsFriends  
    EquivalentTo: MarysFriends, {Bob , Mary}  
Class: MarysFriends  
    EquivalentTo: JohnsFriends, {MsKeller , Mueller}  
Individual: Bob  
    Types: Teacher, not (Woman)  
Individual: Mary  
    Types: Artist, Woman  
Individual: MsKeller  
    Types: Woman  
Individual: Mueller

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | JohnsFriends | MarysFriends | Teacher | Artist | Woman |
| Bob | + | + | + | ? | - |
| Mary | + | + | ? | + | + |
| MsKeller | + | + | ? | ? | + |
| Mueller | + | + | ? | ? | ? |

## Part II: Subsumption Checking (2 points)

Task 9

Given is an OWL ontology in Manchester Syntax.

ObjectProperty: eats  
Class: Cereals  
Class: Egg  
Class: Fish  
Class: Fruits  
Class: Meat  
Class: Milk  
Class: Vegetables  
DisjointClasses:   
    Cereals,Egg,Fish,Fruits,Meat,Milk,Vegetables  
Class: Person  
    SubClassOf: eats some Food  
    DisjointWith: Food    
Class: Food  
    EquivalentTo: Cereals or Egg or Fish or Fruits or Meat or Milk or Vegetables  
    DisjointWith: Person  
Class: Carnivor  
    EquivalentTo: Person and (eats only (Fish or Meat))  
Class: Frutarier  
    EquivalentTo: Person and (eats only Fruits)  
Class: Vegan  
    EquivalentTo: Person and (eats only (Cereals or Fruits or Vegetables))  
Class: Vegetarian  
    EquivalentTo: Person and (eats only (not (Fish or Meat)))  
Class: xPerson  
    SubClassOf: Person and (eats some Fruits)  
Class: yPerson  
    EquivalentTo: Person and (eats some Fruits)  
Class: zPerson  
    EquivalentTo: (eats some Cereals) and (eats some Fruits) and (eats some Vegetables)  
    SubClassOf: Person

Your task is to find the pairwise semantic relationships of classes Carnivor, Frutarier, Vegan, Vegetarian, zPerson, xPerson, yPerson. Indicate the relationships in the cells in the table below using the following symbols:

* subclass of ⊑
* equivalent to ≡
* superclass of ⊒
* disjoint with ⊑¬
* none of the above leave empty

As an example, the semantic relationship *xPerson is subclass of yPerson* is already indicated in the table.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | yPerson | xPerson | zPerson | Vegetarian | Vegan | Frutarier | Carnivor |
| Carnivor | ⊑¬ | ⊑¬ | ⊑¬ | ⊑¬ | ⊑¬ | ⊑¬ | ≡ |
| Frutarier | ⊑ |  | ⊑¬ | ⊑ | ⊑ | ≡ |  |
| Vegan | ⊑ |  | ⊒ | ⊑ | ≡ |  |  |
| Vegetarian | ⊑ | ⊒ | ⊒ | ≡ |  |  |  |
| zPerson | ⊑ |  | ≡ |  |  |  |  |
| xPerson | ⊑ | ≡ |  |  |  |  |  |
| yPerson | ≡ |  |  |  |  |  |  |