Logica Computazionale

MidTerm Solutions

11 Novembre 2024

TOTALE: 36pt

Durata 100 minuti

Lista esercizi (36pt)

1. **Theory. Mental representation (2pt).**
2. **Theory. Model theory (2pt).**
3. **Theory. Model theory (2pt).**
4. **Theory. World models (4pt).**
5. **Practice. Informal to formal - LoE (4pt).**
6. **Practice. Informal to formal (2) - LoE (3pt).**
7. **Practice. Informal to formal - LoE semantics (6pt).**
8. **Practice. Reasoning in LoE (3pt).**
9. **Theory. LoD Theory and Semantics (3pt).**
10. **Practice. Informal to Formal LoD (4pt).**
11. **Practice. Informal to Formal LoD (3pt).**

1. Theory. Mental representations (2pt)

Which of the statements below are true (one or more)?

1. It is impossible that the mental representations of two people who are looking at the same real-world phenomenon are mutually inconsistent
2. It is possible that the mental representations of two people who are looking at the same real-world phenomenon are so similar that they can be described linguistically in the same way
3. Given an analogical representation, there is only one linguistic representation which describes it
4. World representation languages are introduced to minimize the impact of the subjectivity of mental representations
5. World representation languages are introduced to eliminate the impact of the subjectivity of mental representations

SOLUTIONS

1. False
2. True
3. False
4. True
5. False

2. Theory. Model theory (2pt)

Which of the statements below are true (one or more)?

1. A percept is something or some combination of things which is perceived as part of an analogical representation, as distinct from other percepts.
2. A fact, as formalized in set theory, is a relation among percepts
3. Given a set of percepts, a domain of interpretation is any set of facts which can be defined starting from the percepts, not necessarily all the facts which can be possibly defined
4. A model is any subset of the facts in the reference domain of interpretation

SOLUTIONS

1. True
2. True
3. True
4. False, a model cannot contain two facts which are mutually inconsistent, that is, it must describe a possible real world state of affairs

3. Theory. Model theory (2pt)

How many types of percepts are defined in set theory as part of the theory of models? Please write the names.

SOLUTION: There are six types of percepts. Their names are: entities, entity properties, entity relations, etypes, etype properties, etype relations. Other names involving data types, data and object properties are also acceptable.

4. Theory. World models (4pt)

Assume you have a formal world model. Which of the statements below are true (one or more)?

1. A language must be correct and complete with respect its domain of interpretation
2. An interpretation function is defined for all the assertions of the language
3. It is not possible to have two assertions for which the interpretation function returns the same fact
4. It is not possible to have an assertion for which the interpretation function returns two different facts
5. All the facts in the domain of interpretation are in the codomain of the interpretation function
6. If M ⊧ T, to be read as "M entails T", then all assertions in T are true in M
7. Let "a" be an assertion and I an interpretation function. If a fact f = I(a) is true in a model M ed M ⊧ T, then "a" is an assertion in T.
8. A set of assertions can be a theory of more than one models and, dually, a set of facts can be a model of more than one theory.

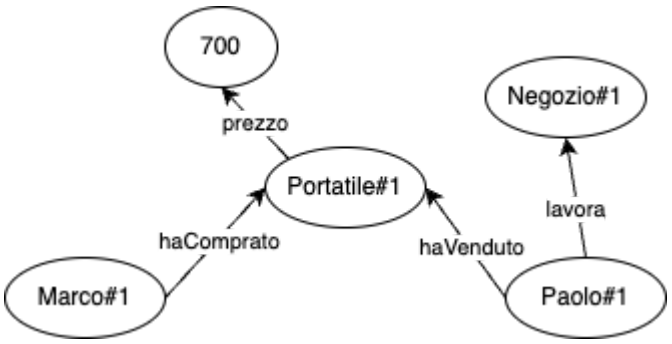
SOLUTIONS

1. False
2. True
3. False
4. True
5. False
6. True
7. False. A theory is an incomplete description of the world. A fact may not be represented by an assertion of a certain theory.
8. True

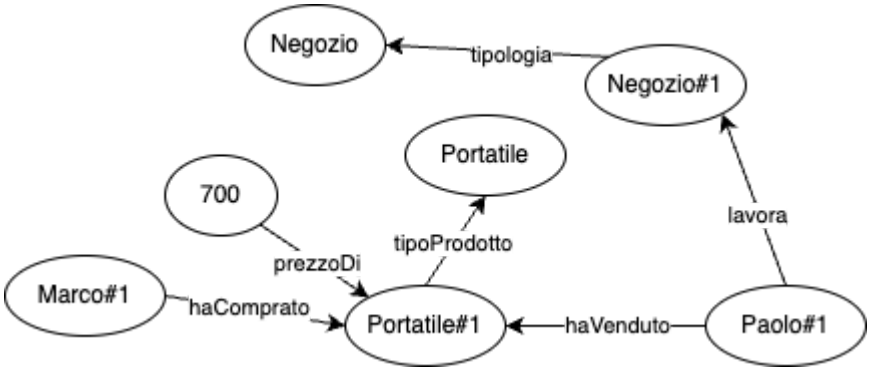
5. Practice. Informal to formal LoE (4 pt)

Indicate which of the knowledge graphs below, can be fully formalized in LoE, without loss of information (one or more graphs). Only the names of instances contain the symbol “#”, numbers must considered as values of dtypes.

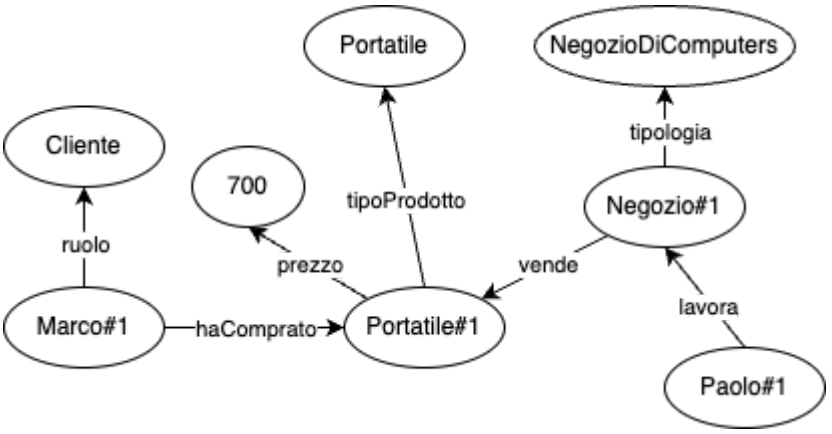
Graph No. 1



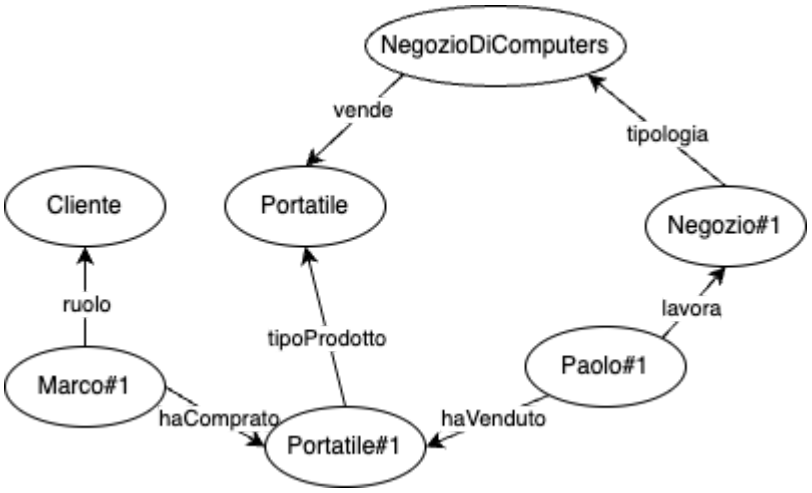
Graph No. 2



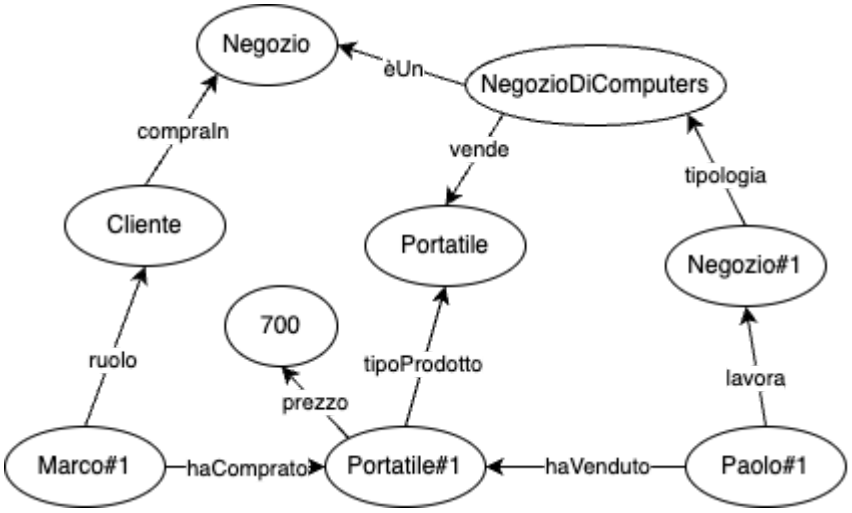
Graph No. 3



Graph No. 4



Graph No. 5

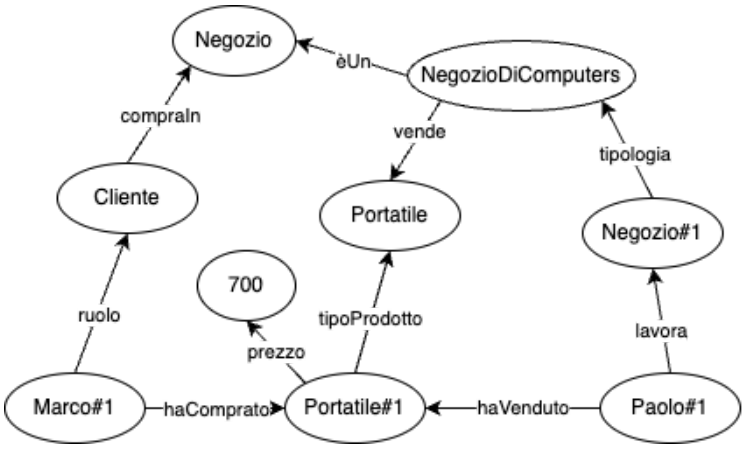


SOLUTIONS

1. True
2. False
3. True. The only possible relation between entities and etypes is membership.
4. False
5. False

6. Practice. Informal to formal LoE (2) (3 pt)

Consider the knowledge graph below. Only the names of entities contain the symbol "#", numbers must considered as values of dtypes. Which of the statements below are true (one or more)?



1. If the triple<portatile#1, tipoProdotto, Portatile > was formalized in LoE, “tipoProdotto” would have to be formalized as an object property
2. If the triple <portatile#1, Prezzo, 700> was formalized in LoE, “Prezzo” would have to be formalized as a data property
3. In LoE, the triple <Negozio#1, Tipologia, NegozioDiComputers> should be formalized as “Negozio#1” member of the etype “NegozioDiComputers”
4. The triple <NegozioDiComputers, vende, portatile> can be formalized in LoE
5. The triple <NegozioDiComputers, èUn, negozio> can be formalized in LoE

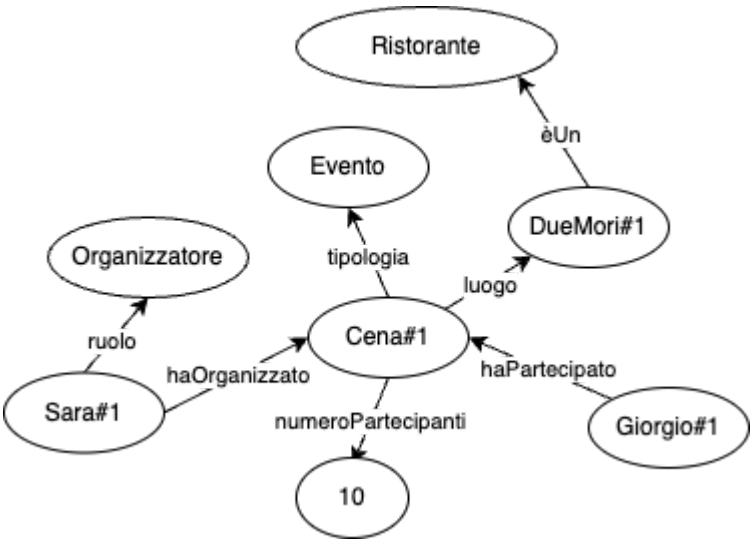
SOLUTIONS

1. False
2. True, given that the 700 is an integer, this must be a data property
3. True, natural language uses a lot of alternative words for representing set membership
4. False, this is a LoD assertion
5. False, this is a LoD assertion

7. Practice. LoE Semantics (6 pt)

Consider the Knowledge Graph below. Assume there are no synonyms. Assume the following: (1) “numeroPartecipanti” is formalized using the data type integer, (2) “entity” is the entity types of all entities, and (3) dtype is the datatype of all datatype values. Only the names of instances contain the symbol “#”, numbers are datatype values.

Indicate for which of the LoE interpretation domains D listed below, with D = <U, {C}, {R}>, there exists an interpretation function which correctly formalizes the graph contents



1. (V) The domain D is organized as follows:
    a. U = {Sara#1, Giorgio#1, Cena#1, DueMori#1, 10}
    b. {C} = {Organizzatore, Evento, Ristorante, integer, entity, dtype}
    c. {R} = {haOrganizzato, haPartecipato, luogo, numeroPartecipanti}
2. (F)The domain D is organized as follows:
    a. U = {Sara#1, Giorgio#1, Cena#1, DueMori#1, 10.0}
    b. {C} = {Organizzatore, Evento, Ristorante, entity, dtype}
    c. {R} = {haOrganizzato, haPartecipato, luogo, numeroPartecipanti}
3. (F) The domain D is organized as follows:
    a. U = {Sara#1, Giorgio#1, Cena#1, DueMori#1, 10}
    b. {C} = {Organizzatore, Evento, Ristorante, Lavoratore, dtype}
    c. {R} = {haOrganizzato, haPartecipato, luogo, numeroPartecipanti}
4. (V)The domain D is organized as follows:
    a. U = {Sara#1, Giorgio#1, Cena#1, DueMori#1, 10}
    b. {C} = {Evento, Ristorante, entity, dtype}
    c. {R} = {haOrganizzato, haPartecipato, luogo, numeroPartecipanti}
5. (V) The domain D is organized as follows:
    a. E = {Paola, Giorgio, Cena#1, DueMori#1, 10}
    b. {C} = {Organizzatore, Evento, Pizzeria, entity, dtype}
    c. {R} = {haOrganizzato, haPartecipato, luogo, numeroPartecipanti}
6. (F) The domain D is organized as follows:
    a. U = {Sara#1, Giorgio#1, Cena, DueMori, 10}
    b. {C} = {Organizzatore, Evento, Ristorante, entity, dtype}
    c. {R} = {haOrganizzato, haPartecipato, numeroPartecipanti}
7. (V) The domain D is organized as follows:
    a. U = {Sara, Giorgio, Cena, DueMori, 10, 11, 12, 13, 14.0, 15.1, 10.2}

b. {C} = {Organizzatore, Evento, Ristorante, entity, integer, real, dtype}
c. {R} = {haOrganizzato, haPartecipato, luogo, numeroPartecipanti}

SOLUTIONS

1. True.
2. False: 10.0 cannot be used to name 10 (float vs integer)
3. False: there is no etype for Giorgo#1
4. True: entity is the etype of all entities, including i Sara#1
5. True: same as 1, but with names which are different. The names used in defining the denotatio of entities in the domain play no role (differently from etypes)
6. False: A relation is missing
7. True. A domain may have more elements and more etypes than those represented by the language.

8. Practice. Reasoning in LoE (3 pt)

Consider the LoE model defined by the assertions listed below

Aspirapolvere(VC#1)
Aspirapolvere(VC#2)
Elettrodomestico(VC#2)
Elettrodomestico(VC#3)
EnergiaConsumata(VC#1, 120W)
EnergiaConsumata(VC#2, 1000W)
SenzaFili(VC#1)
Elettrico(VC#2)
Appartiene(Mary#1, VC#1)
Persona(Mary#1)

Indicate which of the statements below is true (one or more). CWA means “Closed World Assumption”. OWA means “Open World Assumption”

1. Assuming CWA, {VC#1, VC#2} are the only entities which are “Aspirapolvere”
2. Assuming OWA, it is unknown whethen VC#1 is an “Elettrodomestico”.
3. Assuming CWA, it is known that VC#3 is not an “Aspirapolvere”.
4. Assuming OWA, VC#1 uses a “Batteria”.
5. Assuming OWA, VC#1 is not “Elettrico”.
6. Assuming OWA, Mary#1 is not an “Aspirapolvere”.
7. Assuming OWA, Mary#1 is an “Aspirapolvere”.

SOLUTIONS

1. True
2. True
3. True
4. False
5. False
6. False, because of OWA you know nothing about whether Mary#1 and Aspirapolvere
7. False

9. Theory. LoD Logic and Semantics (3pt)

Consider the following statements about the semantics of the Logic of Descriptions (LoD). Indicate which of them is True (one or more):

1. The alphabet of LoD contains words which denote the units in the universe of interpretation U
2. The alphabet of LoD contains words which denote subsets of the Universe of interpretation U
3. A LoD definition can only use the symbol for equivalence
4. If E1 $\perp$ E2, where E1, E2 are two etypes, then E1 is subsumed by the complement of E2 and E2 is subsumed by the complement of E1
5. $I(\exists P.C) = \{d \in U \mid \text{there exists } e \in U \text{ with } (d,e) \in I(C) \text{ and } d \in I(P)\}$

SOLUTIONS

1. False, LoD does not talk about entities
2. True
3. False
4. True
5. False, check the definition

10. Practice. LOD: Informal to formal LoD (4pt)

Indicate which of the formalizations in the various sub-languages of the Logic of Descriptions (lOD) of the natural language sentences below is correct (one or more):

1. The formalization of "Le entità che vivono in un edificio" in the "Language of composite Etype percepts" is

   $\exists$ viveIn.Edificio (V)

2. The formalization of "le entità che parlano solo con quelli che non hanno amici" in the "Language of etype percepts" is

   $\forall$ talksTo.($\exists$ hasFriend. $\bot$) (V)

3. The formalization of "Un cuoco è una persona che lavora in un ristorante" in the "Language of Composite Etype Percepts" is

   Cuoco $\sqsubseteq$ Persona $\sqcap$ $\exists$ lavoraIn.Ristorante (F)

4. The formalization of "I piatti vegetariani sono esattamente quelle pietanze che non contengono carne di maiale" in the "Language of Definitions" is

   PiattoVegetariano $\equiv$ Pietanza $\sqcap$ $\neg$ $\forall$ contiene.Carne (F)

5. The formalization of "Gli smartphone sono dispositivi personali usati per chiamare e messaggiare" in the "Language of Definitions" is

   Smartphone $\sqsubseteq$ Dispositivo $\sqcap$ Personale $\sqcap$ $\exists$ usatoPer. (Chiamare $\sqcap$ Messaggiare) (F)

6. The formalization of "Gli smartphone sono dispositivi personali usati per chiamare e messaggiare" in the "Language of Definitions" is

   Smartphone $\sqsubseteq$ Dispositivo $\sqcap$ Personale $\sqcap$ $\exists$ usatoPer. (Chiamare $\sqcup$ Messaggiare) (V)

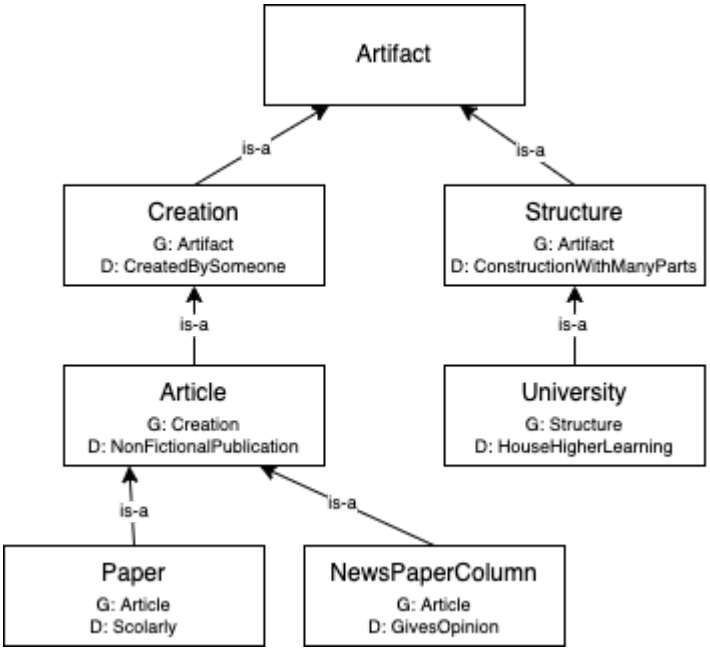
7. The formalization of "I veicoli che hanno una batteria che non si può ricaricare pedalando" in the "Language of Composite Etype Percepts" is

   Veicolo $\sqcap$ $\exists$ haBatteria.(Batteria $\sqcap$ $\neg$ $\exists$ ricaricataDa.Pedalata) (V)

SOLUTIONS:

1. True, it is a primitive etype percept and therefore also a composite etype percept
2. True, it is a composition object properties
3. False, this sentence cannot be expressed in the language of composite etype percepts
4. False
5. False, in this sentence “e” (“and”) must be translated as union
6. True, see answer 5
7. True

11. Practice. Informal to Formal Lexicon in LoD (3pt)



Given the above lexicon and the ontology formalizing it, indicate which of the statements below are true (one or more).

1. The assertion “Creation⊥Structure” is satisfiable
2. The assertion “Paper ⊑ ¬University” is not satisfiable
3. The assertion “Paper ≡¬University” is not satisfiable
4. The assertion “Paper ⊑ Artifact” is satisfiable
5. The unfolding of “University” is “Artifact ⊓ ConstructionWithManyParts ⊓ HouseHigherLearning”
6. The unfolding of “Paper” is “Artifact ⊓ CreatedBySomeone ⊓ Scholarly”

SOLUTIONS:

1. True
2. False
1. True. Differentias are not allowed to denote empty sets. The elements in ¬ University which are in Structure are not in Creation or any of its subsets
3. True
4. True
5. False