



UNIVERSITÀ  
DI TRENTO



# Computational Logic Exercises

## Module II – Set theory and knowledge graphs

Vincenzo Maltese

## Avvisi

**Lezione del 3/11** sarà di Q&A, tenuta da Giunchiglia

Potete inviare a lui via email dubbi e/o esercizi che desiderate discutere il 3/11.

**Midterm exam 6/11** su piattaforma Moodle

Esame da prenotare su piattaforma ESSE3

Aule A201, A202, B106 con orario di arrivo alle ore 8:00

Durata sarà probabilmente 1h 30m – 1h 40m durata

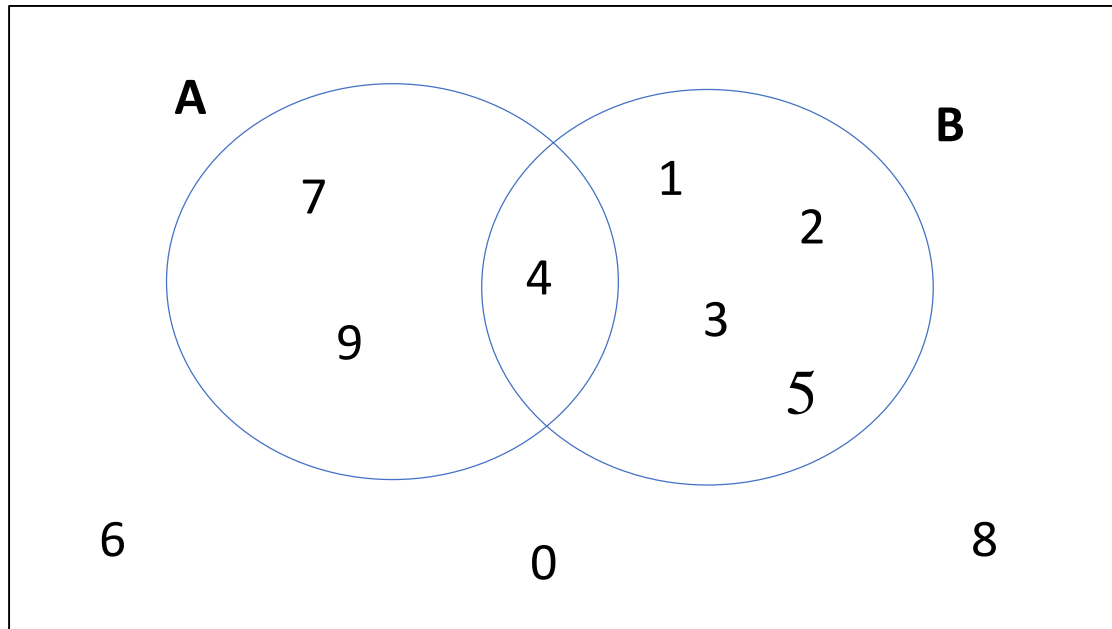
Avvisare Giunchiglia e la Didattica OnLine se c'è qualcuno che ha bisogni speciali per avere più tempo.

## Set theory (I)

The sets A and B consist of numbers from 0 to 9, such that:

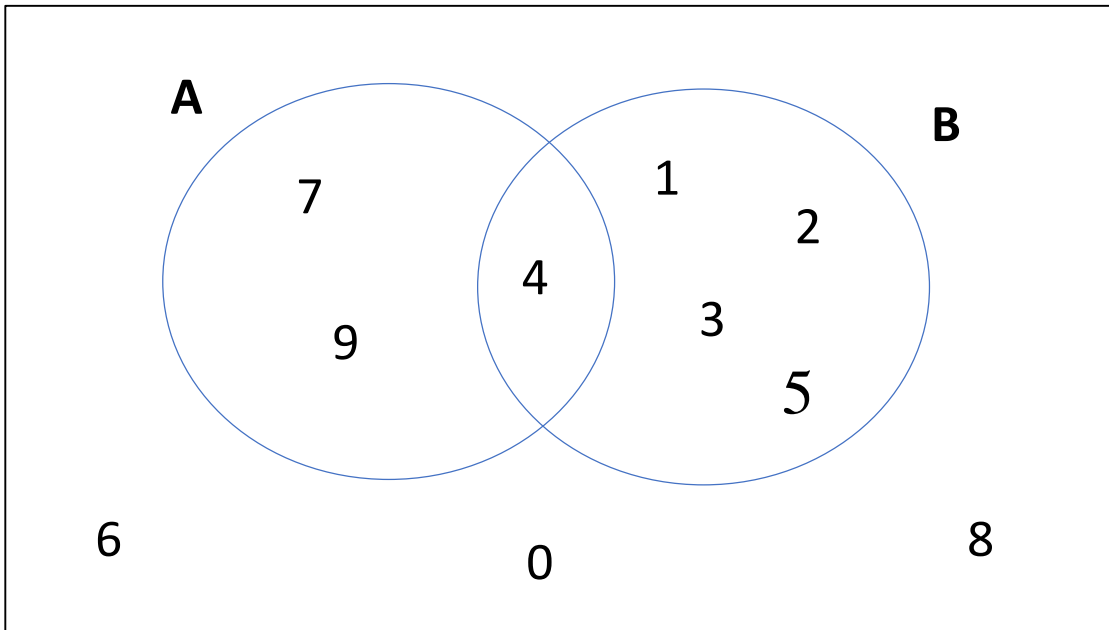
$$A = \{4, 7, 9\} \quad B = \{1, 2, 3, 4, 5\}$$

Illustrate these sets in a Venn diagram.



## Set theory (II)

Given the Venn diagram below, say which of the following statements are true.



- a. A is the empty set
- b.  $4 \in A$  and  $4 \in B$
- c.  $A \subseteq B$
- d.  $0 \notin A$
- e. The universal set U contains all the numbers from 0 to 9

**ANSWER:** b, d, e

## Set theory (III)

**Provide 3 examples of relations between people** that are (a) symmetric and transitive, and (b) anti-symmetric.

**ANSWER:**

(a) brother of, colleague of, roommate of;

**ANSWER:**

(b) parent of, mother of, manager of.

## Key questions

**What is a knowledge graph from the point of view of the graph theory?**

**ANSWER:** it is a directed labelled graph. Notice that it can be eventually cyclic, according to the phenomenon to be modelled.

## Designing knowledge graphs (I)

**Represent with a knowledge graph the following model: “Fausto works for the University of Trento, that is located in Italy” and convert it into triples.**



<Fausto> <worksFor> <University of Trento>

<University of Trento> <locatedIn> <Italy>

## Designing knowledge graphs (II)

Represent with a knowledge graph the following linguistic model: “Fausto and Mario work for the University of Trento, that is located in Italy” and convert it into triples.

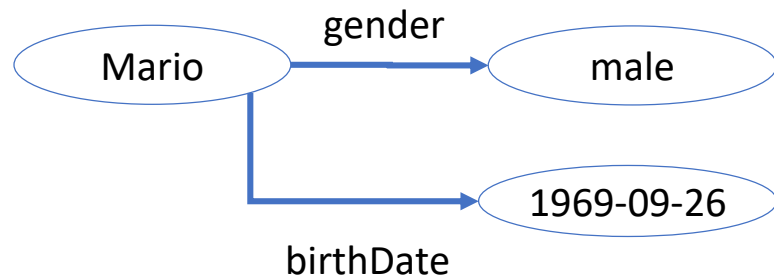


<Fausto> <worksFor> <University of Trento>  
<Mario> <worksFor> <University of Trento>  
<University of Trento> <locatedIn> <Italy>



## Designing knowledge graphs (III)

Represent with a knowledge graph the following linguistic model: “Mario is male and is born on 1969-09-26” and convert it into triples.




<Mario> <gender> <male>

<Mario> <birthDate> <1969-09-26>

# Designing knowledge graphs (IV)

Represent the content of the following webpage as a knowledge graph



**Fausto Giunchiglia**  
 🎓 **Full professor**  
 Department of Information Engineering and Computer Science

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 tel. 0461 281533  
 fausto.giunchiglia@unitn.it  
 | <https://www.disi.unitn.it/~fausto/>

**Expertise:** Access control Artificial Intelligence Automated reasoning Big data Data integration  
 Information & Communication Technology (ICT) Knowledge management Multi-agent systems  
 Natural language processing Personal life Pervasive computing Privacy Semantic interoperability  
 Semantic search Semantic web

Teaching Publications Dissertations and Theses **Projects** Office Hours



19 results 10 20 50

This section provides the list of research projects funded by external organizations, or by UniTrento, on a competitive basis, for which the person is the main scientific responsible person. Data source: UniTrento Projects Register


Title	Start date ↓	End date
<a href="#">+</a> Joint Industrial Data Exchange Pipeline	01/06/2022	31/05/2025
<a href="#">+</a> DELPhi - DiscovEring Life Patterns	29/08/2019	28/08/2023

# Designing knowledge graphs (V)


Represent the content of the following webpage as a knowledge graph




HOME




PEOPLE




EXPERTS AND COMPETENCES



STATUTORY BODIES




DEPARTMENTS AND CENTRES




ORGANIZATIONAL UNITS

### Department of Cellular, Computational and Integrative Biology - CIBIO

academic department 


Director: Paolo Macchi  
Via Sommarive, 9, Povo, 38123 TN  
<http://www.cibio.unitn.it>

### Department of Civil, Environmental and Mechanical Engineering

academic department 


Director: Oreste S. Bursi  
Via Mesiano, 77, 38123 Trento  
<http://www.dicam.unitn.it/>

### Department of Economics and Management

academic department 


Director: Flavio Bazzana  
Via Vigilio Inama, 5, Trento, 38122 TN  
<http://www.economia.unitn.it>

### Department of Humanities

academic department 


Director: Marco Gozzi  
Via Tomaso Gar, 14, Trento, TN  
<http://www.lettere.unitn.it/>

### Department of Industrial Engineering

academic department 

Director: Alessandro Pegoretti  
Via Sommarive, 9, Povo, 38123 TN  
<http://www.dii.unitn.it>

### Department of Information Engineering and Computer Science

academic department 

Director: Paolo Giorgini  
Via Sommarive, 9, Povo, 38123 TN  
<https://www.disi.unitn.it>

## Interpreting knowledge graphs

**Given the following knowledge graph, come up with an equivalent representation in natural language.**



**A POSSIBLE ANSWER:** The University of Trento was funded on 1962. Fausto is a professor of the University of Trento. Mario is a director of the University of Trento.

## Etype graphs (I)

### Movie

A Schema.org Type

Thing > CreativeWork > Movie

A movie.

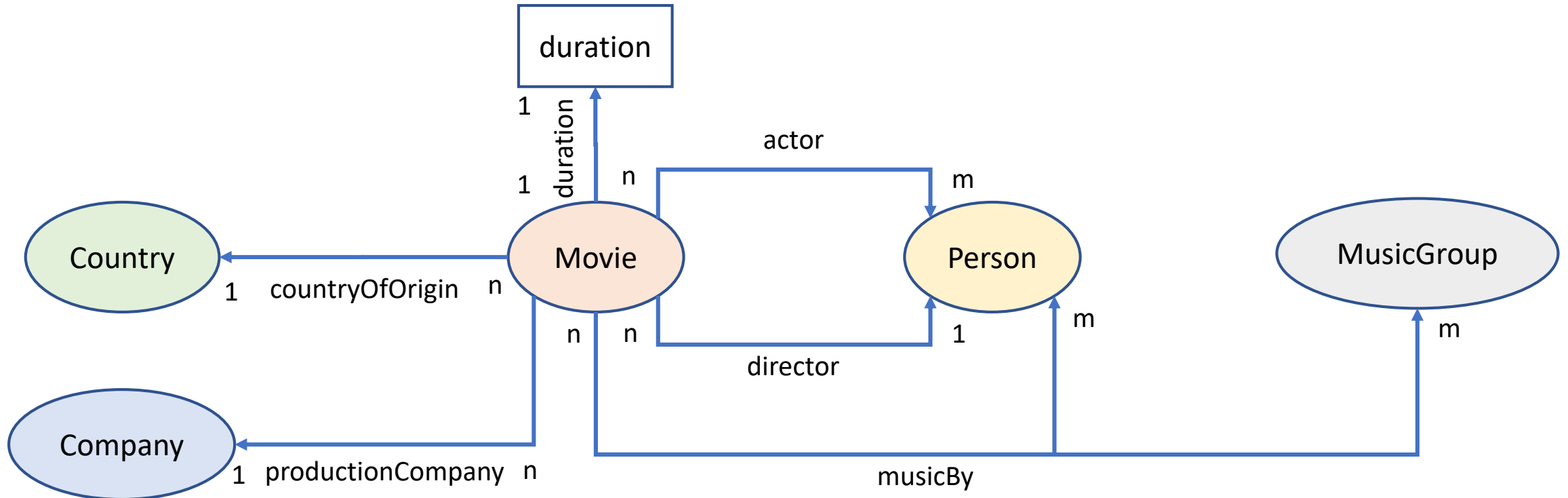
[more...]

**Schema.org** is an example of ETG.

Property	Expected Type	Description
<b>Properties from Movie</b>		
<code>actor</code>	Person	An actor, e.g. in TV, radio, movie, video games etc., or in an event. Actors can be associated with individual items or with a series, episode, clip. Supersedes <code>actors</code> .
<code>countryOfOrigin</code>	Country	<p>The country of origin of something, including products as well as creative works such as movie and TV content.</p> <p>In the case of TV and movie, this would be the country of the principle offices of the production company or individual responsible for the movie. For other kinds of CreativeWork it is difficult to provide fully general guidance, and properties such as <code>contentLocation</code> and <code>locationCreated</code> may be more applicable.</p> <p>In the case of products, the country of origin of the product. The exact interpretation of this may vary by context and product type, and cannot be fully enumerated here.</p>
<code>director</code>	Person	A director of e.g. TV, radio, movie, video gaming etc. content, or of an event. Directors can be associated with individual items or with a series, episode, clip. Supersedes <code>directors</code> .
<code>duration</code>	Duration	The duration of the item (movie, audio recording, event, etc.) in ISO 8601 date format.
<code>musicBy</code>	MusicGroup or Person	The composer of the soundtrack.
<code>productionCompany</code>	Organization	The production company or studio responsible for the item, e.g. series, video game, episode etc.

## Etype graphs (II)

Provide a graphical representation of the Movie etype as a Knowledge graph.



## Test yourself (a)

**Given the knowledge graph above and their corresponding representation in natural language say if they are mutually consistent and motivate your answer.**



**The University of Trento was funded on 1962. Fausto is a professor of the University of Trento. Mario is a director of the University of Trento.**

**ANSWER: YES, BECAUSE THERE IS AN EXACT CORRESPONDENCE.**

## Test yourself (b)

**Given the knowledge graph above and their corresponding representation in natural language say if they are mutually consistent and motivate your answer.**



**The University of Trento was funded on 1962. Fausto and Mario work for the University of Trento.**

**ANSWER: NO, BECAUSE WE DID NOT SPECIFY IN THE GRAPH THE “WORKS FOR” RELATION.**



## Test yourself (c)

**Given the knowledge graph above and their corresponding representation in natural language say if they are mutually consistent and motivate your answer.**



**The University of Trento was funded on 1962. Fausto is a professor of the University of Trento.**

**ANSWER: YES, IT IS CONSISTENT DESPITE NOT COMPLETE.**

## Homework (I)

### Answer to the following questions

1. What makes a modelling language formal?
2. What is the difference between a directed graph and an undirected graph?
3. Is a knowledge graph the result of a modelling activity?
4. What exactly do you represent with knowledge graphs?
5. What are the advantages of a knowledge graph w.r.t. other representations?
6. In the context of knowledge graphs, what is the difference between an entity type and a data type?
7. In the context of knowledge graphs, what is the difference between object properties and data properties?

## Homework (II)

**EXERCISE 1:** Represent with a knowledge graph the following model: “University of Trento (officially “Università degli Studi di Trento”) was founded on 1962. Its institutional address is via Calepina, 14 - 38122 Trento. Its web site is <https://www.unitn.it/>. It is research partner of Fondazione Edmund Mach” and convert it into triples.

**EXERCISE 2:** Represent with a knowledge graph the following linguistic model: “Alice and Bob both own a Fiat Panda. Alice bought a new one in 2023, while Bob’s was a second hand vehicle from 2013 that he bought in 2018.” and convert it into triples.

## Homework (III)

**EXERCISE 3:** Design a comprehensive knowledge graph from the following models

M1: cure A worked with patient 1 affected by disease X; patient 1 is male

M2: cure A worked with patient 2 affected by disease X; patient 2 is male

M3: cure A did not work with patient 3 affected by disease X; patient 3 is female

**EXERCISE 4:** Design a comprehensive knowledge graph from the following picture

