

Artificial Intelligence
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PART II – Knowledge Representation
December 13th, 2017

First Name and Last name

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The results of the exams of all the students will be posted in a single file in the Moodle web page. Each student will be identified only by his/her ‘Matricola’ code (Sapienza registration number). If you do not agree on having your grade listed in this file, please check this box:

NO-WEB [☐]

Maximum time is 75 minutes. You can use neither the text books nor your notes.

Students enrolled in the academic year 2016/17 in the Master Degree in Artificial Intelligence and Robotics, please check this box: [☐].

Students enrolled in the academic year 2017/18 in the Master Degree in Artificial Intelligence and Robotics, please check this box: [☐].

Students enrolled in academic year 2016/17 in the Master Degree Engineering in Computer Science and any other curricula that include a 6 ECTS course in Artificial Intelligence, please check this box: [☐]

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Exercise 1 (8 points)

D is the gardener of a vegetable garden V and a flower garden F. Gardens that have a gardener are beautiful iff their gardener waters them. Every gardener waters his gardens, if water is available, which is fortunately the case for D.

- (a) Define a vocabulary (i.e., constant, function and predicate symbols) and represent the following sentences in first order logic.
- (b) translate the sentences in clausal form
- (c) show using resolution that V and F are beautiful.

Exercise 1d

Tell which one among the following First Order Logic formulas is an adequate representation of the sentence (and provide an explanation of the answer):

Italians are happy if the Italian National team wins the world cup.

- a1. $\forall x \forall y [(italian(x) \Rightarrow (winWC(y) \Rightarrow happy(x)))]$
- a2. $\forall x \forall y [(italian(x) \wedge winWC(y)) \Rightarrow (happy(x))]$
- a3. $\forall x \exists y [(italian(x) \wedge winWC(y)) \Rightarrow happy(x)]$
- a4. $\forall x [(italian(x) \wedge winWC(National)) \Rightarrow happy(x)]$
- a5. $\forall x [(italian(x) \wedge winWC(National)) \wedge happy(x)]$
- a6. $\forall x [(italian(x) \wedge happy(x)) \Rightarrow winWC(National)]$

Exercise 2 (4 points)

Describe the notion of taxonomic reasoning; provide a formal characterization and examples of universal role quantification.

Exercise 3 (4 points)

Write a PROLOG program that given a list of lists of integers and an integer N returns a list containing only the lists of the input structure that have less than N elements. The check on the length of the list must be implemented. For example, given the input $[[1,2,3],[1,5],[4,6]]$ and N is 3 the answer is $[[1,5],[4,6]]$.

Exercise 1 (8 points)

D is the advisor of two PhD students F and A, who are both motivated. PhD students who have an advisor are successful iff their advisor cares about them. Every advisor cares about his/her students, when they are motivated.

- (a) Define a vocabulary (i.e., constant, function and predicate symbols) and represent the following sentences in first order logic.
- (b) translate the sentences in clausal form
- (c) show using resolution that F and A are successful

Exercise 1d

Tell, among the following formulas, which one adequately represents the sentence (and provide an explanation of the answer):

Among all animals, Mary loves all cats and no dogs.

- (i) $\forall x \text{ animal}(x) \Rightarrow (\text{loves}(\text{Mary}, x) \Rightarrow (\neg \text{dog}(x) \wedge \text{cat}(x)))$
- (ii) $\forall x \text{ animal}(x) \Rightarrow ((\text{dog}(x) \Rightarrow \neg \text{loves}(\text{Mary}, x)) \wedge (\text{cat}(x) \Rightarrow \text{loves}(\text{Mary}, x)))$
- (iii) $\forall x (\text{animal}(x) \Rightarrow (\text{cat}(x) \Rightarrow \text{loves}(\text{Mary}, x)))$

Exercise 2 (4 points)

Describe the notion of non monotonic reasoning, provide a definition of Closed World Assumption and examples of use.

Exercise 3 (4 points)

Write a PROLOG program that given a list of lists of integers and an integer N, and returns a list containing only the lists of the input structure, whose elements are all greater than N. For example, given the input `[[1,2,3],[1,5,2],[4,6,8]]` N=2, the answer is `[[4,6,8]]`.