Artificial Intelligence — Final Test

September 13th, 2022

Hand-in instructions

The test must be submitted through the link available on the Aulaweb page for the course "Artificial Intelligence for Robotics 1". The answers for sections 1 and 2 should be submitted in handwritten form in .pdf format (you can use pen-enabled devices or scan handwritten answers on paper). Please try to be as clear as possible. You must supply text files for the answer to section 3. Overall, your hand-in should be a single zipped file < *student_id* >_<*surname*>, and if you have more than one surname, please use camel case (not spaces) to separate words.

During the test you do not have to keep your webcam switched on (if you are doing the test remotely) and you can consult your notes and other references on your PC or the internet (the exam is open-book). You must not ask help to your fellow colleagues or others. By submitting the exam, you implicitly state that you are adhering to this policy.

1 Propositional Logic

Given the following formulas in propositional logic

- φ_1: $(p \rightarrow q)$
- φ_2: $(q \rightarrow (s \wedge t))$
- φ_3: $(r \rightarrow (s \wedge t))$
- φ_4: $(p \vee r)$

show whether the formula $s \wedge t$ is a logical consequence of the theory $\Phi = \{\varphi_1, \varphi_2, \varphi_3, \varphi_4\}$. State your answer as a proof using a deduction mechanism of your choice. Truth-tables are not accepted as an answer.

2 First Order Logic

Consider the following sentences in First Order Logic:

1. $\forall x.R(x, x)$
2. $\forall x.\forall y.R(x, y) \rightarrow R(y, x)$
3. $\forall x.\forall y.\forall z.((R(x, y) \wedge R(y, z)) \rightarrow R(x, z))$.

and tell whether the sentence

$$\forall x.\forall y.\forall z((R(x, y) \wedge \neg R(y, z)) \rightarrow \neg R(x, z))$$

is a logical consequence of the first three ones.

3 Planning

Consider a scenario in which you have a set of n locations $l_1, \ldots, l_n$ and a table. You also have n tomatoes initially on the table. Your goal is to have a tomato in each location. In each location there can be at most one tomato. In particular, formalize actions to move tomatoes from the table to the locations, as well as the predicates to characterize the state. Formalize a problem instance where there are four tomatoes and four locations, the tomatoes are initially on the tavle and all the locations are empty.