Artificial Intelligence for Robotics I
Final Test

December 22nd, 2023

Hand-in instructions

The answers for Propositional and First Order Logic questions can be submitted in handwritten form to the teacher, or in .pdf format (you can use pen-enabled devices or scan handwritten answers on paper) through the link made available on the Aulaweb page for the course "Artificial Intelligence for Robotics 1". Please try to be as clear as possible in your handwriting. The answer to the Planning question are to be submitted through Aulaweb, and you must supply two text files in PDDL language for your answer, one named `domain.pddl` for the domain and one named `problem.pddl` containing the definition of the problem instance. 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 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

Formalize the following sentences about a group of friends having a party

1. Alberto and Carola are going to the party
2. Either Beatrice or Daniele (or both) are going to the party
3. If Alberto goes to the party then also Enrico goes to the party
4. If Enrico goes to the party then Daniele does not go
5. If Beatrice goes to the party then either Carola or Alberto do not go

Considering the sentences above, is there going to be someone at the party? State your answer as a proof using a deduction mechanism of your choice or a semantic argument. Truth-tables are not accepted as an answer. (**Note**: the disjunction in sentence (2) is inclusive.)

2 First Order Logic

Consider the following first order theory about cocktails:

1. $\forall x.(Loves(x, negroni) \rightarrow Loves(x, americano))$.
2. $\forall x.(Loves(x, stinger) \vee Loves(x, negroni))$.
3. $\exists x.\neg Loves(x, americano)$.
4. $\exists x.(Loves(x, stinger) \vee Loves(x, negroni))$

and tell whether each of the following sentences is either a logical consequence of the theory or not:

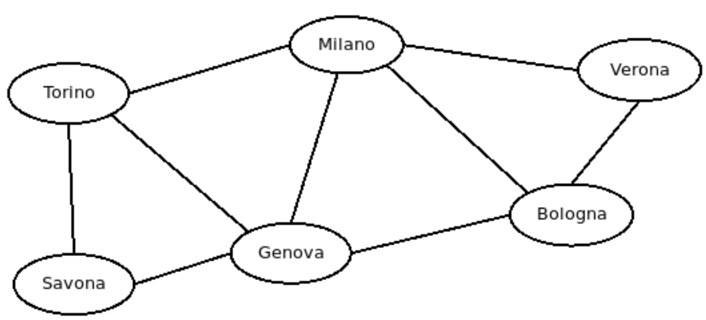
1. $\exists x.(\neg Loves(x, negroni) \wedge \neg Loves(x, stinger))$.
2. $\forall x.(\neg Loves(x, stinger) \rightarrow \neg Loves(x, americano))$.
3. $\forall x.(Loves(x, negroni) \vee Loves(x, americano))$.
4. $\forall x.(Loves(x, americano))$.
5. $\forall x.((Loves(x, negroni) \wedge \neg Loves(x, americano)) \rightarrow \neg Loves(x, stinger))$.

Please state your answers using a deductive mechanism of your choice or a semantic argument.

3 Planning

Consider a variation of the Traveling Salesman Problem (TSP), where a set of cities is connected through roads. The road network is connected and each road is two-way, so every city is reachable from the others albeit not necessarily with a direct connection. The agent starts in a given city and has to visit all of them exactly once, returning to the initial location at the end. No demand is made about the optimality of the tour which is required in the classical TSP formulation.

Formalize the fluents and the operators required for the TSP domain and a problem instance with six cities connected as shown in the picture below:



assuming that the starting city is Genova and the goal is to visit all the cities exactly once and then return to Genova.