MASTER IN ARTIFICIAL INTELLIGENCE (UDC - USC - UVigo)

REASONING AND PLANNING exam. June 17th, 2024

Surname: ____

First Name: ____

INSTRUCTIONS This exam covers units 1-6 and is weighted with a maximum of **42 points (pt) from a total of 100 pt** in the whole course (Unit 7 is not covered in the exam and weights 8 pt). For the test, use the original statement sheet and avoid corrections or unclear marking (ask for a new blank sheet if needed). **Completion time = 2 hours**.

— EXAM —

Exercise 1 (20pt). Each question has at least one correct answer and its total score depends on whether you check: some incorrect answer = **-3pt**; all the correct answers = **5pt**; only correct answers, but not all = **3pt**; leaving blank = **0pt**. A total negative score in Exercise 1 counts as 0pt in the rest of the exam.

1.1) Mark those formulas below that are equivalent to $p \vee q \rightarrow r$ in classical propositional logic:

□ $(p \rightarrow r) \wedge (q \rightarrow r)$
□ $(p \rightarrow r) \vee (q \rightarrow r)$
□ $\neg r \rightarrow \neg p \wedge \neg q$
□ $\neg(p \wedge q \wedge \neg r)$

1.2) The logic program P with rules `a :- not c.   a :- b   c :- b` is stratified. Mark the rules below that, if they were (individually) added to P, they would make the result a non-stratified program.

□ `c :- a.`

□ `p :- not p.`

□ `b :- a.`

□ `b :- not a.`

1.3) Given the following logic program `p :- q.   p :- not r.   r :- p, not q`

□ the reduct with respect to $\{q\}$ is the program `p :- q.   p :- not r.`

□ the reduct with respect to $\emptyset$ is the program `p :- q.   p.   r :- p.`

□ the reduct with respect to $\{r\}$ is the program `p :- q.   r :- p.`

□ the reduct with respect to $\{p, q\}$ is the program $\boxed{\quad\quad}$

□ the reduct with respect to $\{q\}$ is the program `p :- q.   p.`

1.4) The rule `p :- not r.` used above corresponds to the implication $\neg r \rightarrow p$ that is equivalent to $p \vee r$ in classical logic, but is strictly *stronger* in the the logic of Here-and-There (HT). Mark those HT interpretations that are HT models of $\neg r \rightarrow p$ but not of $p \vee r$.

□ $H = \{p\}$, $T = \{p\}$
□ $H = \emptyset$, $T = \emptyset$
□ $H = \{r\}$, $T = \{p, r\}$
□ $H = \emptyset$, $T = \{r\}$

Exercise 2 (10pt). Write an ASP program that generates all ways to place 4 bishops in a chessboard so that they do not attack each other. Use predicate `bishop(X,Y)` meaning there is a bishop at row `X` and column `Y`. (NOTE: in chess, bishops attack other pieces in the same diagonal).

```
#const n=8.
cell(1..n,1..n).















#show bishop/2.
```

Exercise 3 (8pt). The following `telingo` program tries to move a robot in a grid from an initial position at `(0,0)` to a goal position at `(3,4)`. Complete the program to fulfil the two missing requirements: (1) move the robot to some adjacent position (up, down, left or right); (2) the robot cannot step out of the grid.

```
#program initial.
grid(0..3,0..4).
wall(0,2). wall(2,2).  wall(3,2).   robot(0,0).  goal(3,4).

#program dynamic.
% Move the robot to some adjacent position

_____________________________________________________________ :- 'robot(X,Y).

:- robot(X,Y), _wall(X,Y).      % Do not step into a wall

% Do not step out of the grid

__________________________________________________

#program final.
:- robot(X,Y), not _goal(X,Y).  % Reach the goal at last state
```

Exercise 4 (4pt). Write a formula in Description Logic (DL) that describes the set of red (*Red*) cars (*Car*) that have some foreign (*Foreign*) owner (*owned_by*).