MASTER IN ARTIFICIAL INTELLIGENCE (UDC - USC - UVigo)
REASONING AND PLANNING exam. January 10th, 2025

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 $\neg(p \leftrightarrow q)$ in classical propositional logic:

- ☐ $\neg p \leftrightarrow q$
- ☐ $p \leftrightarrow \neg q$
- ☐ $\neg p \leftrightarrow \neg q$
- ☐ $\top$

1.2) Given the positive logic program P with rules `a :- b, c.  c :- a.  d.  e :- a, b.` mark the correct statements about the direct consequences operator T_P.

- ☐ $T_P(\emptyset) = \{\mathtt{a}, \mathtt{c}, \mathtt{d}, \mathtt{e}\}$
- ☐ $T_P(\{\mathtt{a}, \mathtt{b}\}) = \{\mathtt{c}, \mathtt{d}, \mathtt{e}\}$
- ☐ $T_P(\emptyset) = \{\mathtt{d}\}$
- ☐ $T_P(\{\mathtt{d}\}) = \{\mathtt{d}\}$

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

- ☐ the reduct with respect to $\{\mathtt{p}, \mathtt{q}, \mathtt{r}\}$ is the program [ ]
- ☐ the reduct with respect to $\{\mathtt{p}\}$ is the program `p.  r.`
- ☐ the reduct with respect to $\emptyset$ is the program `p :- not q.  r.  q :- not p, not q.`
- ☐ the reduct with respect to $\{\mathtt{r}\}$ is the program `p.  r.  q.`
- ☐ the reduct with respect to $\{\mathtt{p}, \mathtt{q}\}$ is the program `r.`

1.4) The rule `q :- not p, not q.` used above is actually equivalent to the formula $\neg\neg p \vee \neg\neg q$ in the logic of Here-and-There (HT), but the latter is not equivalent to $p \vee q$ in that logic. Mark those HT interpretations that are HT models of $\neg\neg p \vee \neg\neg q$ but not of $p \vee q$.

- ☐ $H = \{p\}$, $T = \{p\}$
- ☐ $H = \emptyset$, $T = \{p, q\}$
- ☐ $H = \emptyset$, $T = \{p\}$
- ☐ $H = \{p, q\}$, $T = \{q\}$

Exercise 2 (10pt). A lottery ticket in Spain consists of 5 digits, covering the interval from 00000 to 99999. Write an ASP program that generates one answer set per each lottery number that contains one or more odd digits, and one or more repeated digits. Use predicate `ticket(N,D)` to represent that the `N`-th digit in the ticket is `D`.

```
digit(1..9).
position(1..5).
#show ticket/2.
```

Exercise 3 (4pt). The general *inertia default* can be written in `telingo` as the pair of rules

```
#program dynamic.
h(F,V) :- 'h(F,V), not c(F).
c(F) :- 'h(F,V), h(F,W), V!=W.
```

Provide a brief explanation of their meaning:

Exercise 4 (4pt). Suppose we want to solve the Towers of Hanoi problem but using 5 pegs (`a,b,c,d,e`) and assume we use action `move(P,Q)` to move the top disk of peg `P` to the top of peg `Q`. Which is the **branching factor** of this planning problem? [ ]

Exercise 5 (4pt). Write a formula in Description Logic (DL) that describes the set of foreign (*Foreign*) students (*Student*) such that all the courses they enrolled in (*enrolled*) are mandatory (*Mandatory*).