UNIVERSITY OF ABERDEEN **SESSION 2013-2014**

Examination in CS3019 (Knowledge-based Systems)

27 January 2014 **(9:00 – 11:00)**

Candidates are not permitted to leave the Examination Room during the first or last half hours of the examination.

Answer TWO out of the three questions.
Appendix (including some tables and algorithms used in lectures) are available after the questions.

Each question is worth 25 marks; the marks for each part of a question are shown in brackets.

1.

(a) Draw the architecture of Jess expert system shell, and explain the functionalities of each of the components in the architecture. [6]

(b) Assume that the Working Memory of Jess contains the following facts: [6]

Fact-0: (country UK UK UK Spain USA)
Fact-1: (food egg milk butter veg apple pear coke)

Assume that the following patterns are condition elements of the left-hand side (LHS) of rules. Describe whether they will match the facts in Working Memory and if yes, how many activations and what values are bound to any variable used in these patterns because of a match:

```
1. (country UK $? ?x $?)
2. (country $? ?y&:(neq ?y UK) ?x)
3. (country $?x Spain usa)
4. (food $?x&:(not(member$ apple ?x))
  (food $?food-list&:(> (length$ ?food-list) 3) ? $?)
```

(c) Given the following interpretation,

1. $\Delta^I = \{a,b,c,d,e,f,g,h,i,j\}$
2. $Plant^I = \{a,c,f,h\}$
3. $Animal^I = \{d,e,f,j\}$
4. $eat^I = \{ \langle d,a\rangle, \langle a,b\rangle, \langle a,e\rangle, \langle c,j\rangle, \langle c,i\rangle \}$
5. $partOf^I = \{ \langle b,f\rangle, \langle a,h\rangle, \langle h,j\rangle, \langle i,j\rangle \}$

write down the interpretations of the following class descriptions and show your working. [5]

- $Animal \sqcap \neg Plant$
- $\forall eat.(Plant \sqcup \exists partOf.Plant)$

(d) This question is about transforming semantic networks into OWL ontologies.

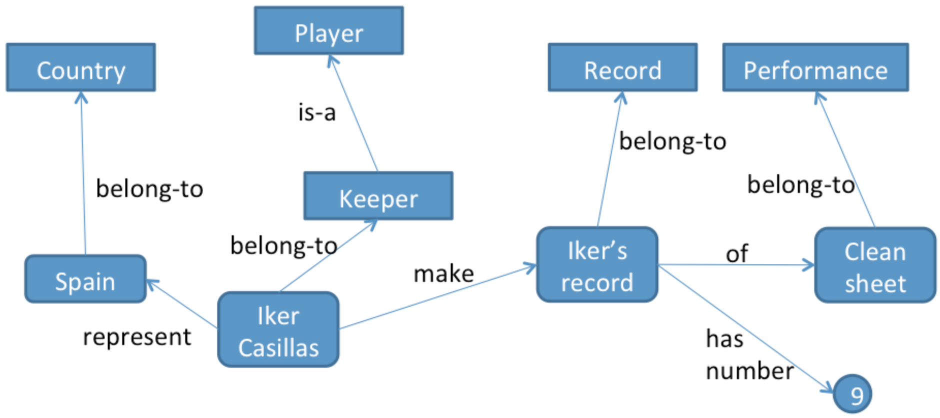
(i) One of the key steps of transforming a semantic network into an OWL ontology is to separate object properties from datatype properties. Explain these two kinds of properties with some examples.

(ii) In addition to this key step, what are the other key steps of transforming a semantic network into an OWL ontology?

(iii)Transform the schema part (i.e., only class and property axioms) of the following semantic network (next page) into an OWL ontology, in both OWL abstract syntax and DL syntax. Show your working.

[8]

TURN OVER


Country
Player
Record
Performance
is-a
belong-to
belong-to
belong-to
Keeper
belong-to
Spain
Iker Casillas
make
Iker's record
of
Clean sheet
represent
has number
9

TURN OVER

2.

(a) Is the following class equivalence valid? Prove your answer. [6]

$$C \sqcap (D \sqcup E) \equiv (C \sqcap D) \sqcup E$$

(b) Are the following two statements correct? [6]

1. Unstructured interviews are usually used in early stages of knowledge capturing and representation.
2. Given an ontology O, if a class A in O is unsatisfiable, then the ontology O is inconsistent.

Justify your answers (in the case of false, you are expected to explain why it is false; in the case of true, you are expected to explain briefly the meaning of the statement).

(c) Explain the difference between condition elements and constraints. [5]

(d) Write a Jess function "insert" (using 'deffunction') that takes three input parameters, i.e. 1) a list of elements; 2) a single element; 3) an index. The "insert" function should be able to:

(1) produce as output a list of elements, for which the single element is added at the index specified (**Note:** you are **NOT** allowed to use the **`insert$`** function). For example, if the input is the following: a list **`(skiing swimming running biking climbing)`**, a single element **`singing`**, and the index **3** then this function should produce the following new list as output **`(skiing swimming singing running biking climbing)`**;

(2) print out each of the elements of the new list to Jess's standard output.

[8]

3.

(a) Explain the difference between forward chaining and backward chaining of rules. [6]

(b)

```
Jess> (clear)
TRUE
Jess> (deftemplate used-car (slot price) (slot mileage))
TRUE
Jess> (deftemplate new-car (slot price) (slot warrantyPeriod))
TRUE
Jess> (defrule might-buy-car
       ?candidate <- (or (used-car (mileage ?m&:(< ?m 50000)))
                         (new-car (price ?p&:(< ?p 20000))))
                   =>
       (assert (candidate ?candidate)))
Jess> (assert (new-car (price 18000)))
<Fact-0>
Jess> (assert (used-car (mileage 30000)))
<Fact-1>
Jess> (assert (used-car (price 20000) (mileage 300)))
<Fact-2>
Jess> (run)
```

Given the above Jess code, will the rule 'might-buy-car' be activated? If not, explain why. If yes, write down any new fact(s) that will be written into the Working Memory, in the order of their activations. Note: by default Jess uses the 'depth' strategy for conflict resolution. [6]

(c) Consider the ontology O consisting of the following axioms:

- Class(Cow partial Herbivore)
- Class(MadCow partial (intersectionOf(Cow restriction(eat someValuesFrom(AnimalComponent)))))
- Class(Herbivore partial restriction(eat allValuesFrom(Vegetable)))
- DisjointClasses(AnimalComponent Vegetable)

Here are your tasks:

i) Write down the above ontology in DL syntax.

ii) Use the tableaux algorithm to check if MadCow is satisfiable.

iii) If it is not satisfiable, which axiom(s) need to be changed to make it satisfiable. [13]

TURN OVER (APPENDIX AVAILABLE)