UNIVERSITY OF ABERDEEN **SESSION 2016-2017**

Examination in CS3025 (Knowledge-based Systems)

5 Dec, 2016 **(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) is available after the questions.

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

1.

(a) Explain how the ordering of activated rules on the agenda can be influenced by a Jess program. [4]

(b) This item concerns software agents and multi-agent systems: [4]

i. What is the relation between agent communication languages (ACLs) and ontologies? [2]
ii. How would you program a reactive agent with rules? [2]

(c) Given the following interpretation,

1. $\Delta^{\mathbf{I}}$ ={a,b,c,d,e,f,g,h,i,j,k,l,m,n,o,p,q,r,s,t}
2. Mobile$^{\mathbf{I}}$ = {a,c,d,e,f,g}
3. CPU$^{\mathbf{I}}$ ={b,h,I,j}
4. Fast$^{\mathbf{I}}$ = {k,l,m}
5. EUCountry$^{\mathbf{I}}$ = {n,o,p,q}
6. hasPart$^{\mathbf{I}}$ ={<a,b>, <d,b>,<e,h>,<f,j>}
7. hasSpeed$^{\mathbf{I}}$ ={<b,r>,<h,k>,<l,m>}
8. from$^{\mathbf{I}}$ = {<a,n>,<b,n>,<c,o>,<l,s>}

work out the interpretations of the following class descriptions and show your working. [5]

- Mobile ⊓ ∃hasPart.(CPU ⊓ ∃hasSpeed.Fast)
- ∀from.(¬EUCountry)

(d) Given the following Book table: [8]

bookID	hasTitle	hasPublisher
B001	Ontology-Driven Software Development	Springer
B002	Semantic Web Enabled Software Engineering	AKA
B003	Exploiting Linked Data and Knowledge Graphs for Large Organisations	Springer
B004	Logical Foundation of Knowledge Graph Constructing and Querying Answering	Springer

(1) Transform the four records into the corresponding RDF statements in N3 syntax, if they are representable in RDF. [4]
(2) The hasPublisher column is a foreign key pointing to the Publisher table. Can you transform this foreign key constraint into RDF/OWL? [1] If so, how? If not, why? [1]
(3) The bookID column is the primary key of the Book table. Can you transform this primary key constraint into RDF/OWL? [1] If so, how? If not, why? [1]

(e) Explain the difference between condition elements and constraints. [4]

2.

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

$$\exists R.(A \sqcap B) \equiv \exists R.A \sqcap \exists R.B$$

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

- One of the advantages of Semantic Net is that it allows to represent default knowledge. [3]
- A competency question can be meaningfully answered only when its presuppositions are satisfied. [3]

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) Use the `while` function to write Jess code which multiplies the numbers from 2 to 8, and then prints out the result. [6]

(d) Based on the partially completed rule extract-list and the facts in the working memory below, work out the following questions [7]

i. Given that variable_A is a multifield variable, complete the pattern on the LHS of the rule. NB: you may create a new name for variable_A. [1]

ii. Suppose statement_1 prints out the value of variable_A. Write down such a statement in Jess code. [2]

iii. Given the facts in the WM, how many times will the rule be activated? Write down the output for all the possible activation(s)/execution(s). [4]

```
(defrule extract-list
      (data ?first variable_A)
      =>
      Statement_1
)

Fact-1: (data tiger whale crow snake spider)
Fact-2: (data Bill Bob Mary Jill)
Fact-3: (data tiger)
```

3.

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

(b) Draw the architecture of Jess expert system shell, and explain the functionalities of each of the components in the architecture.

[6]

(c) Consider the ontology O2 consisting of the following axioms: [13]

Class(PhDS partial Student)
Class(Student partial (intersectionOf(Person restriction(studyIn someValuesFrom(University)))))
Class(University partial Organisation)

Write down the above ontology in DL syntax [3] and use the tableaux algorithm to check if O2 entails the following axiom [10].

$\text{PhDS} \sqsubseteq \exists \text{studyIn.Organisation}$,

TURN OVER (APPENDIX AVAILABLE)