Exam Intelligent Systems, May 21st, 2013, 14.00 – 17.00

There are 9 questions that together are worth 90 points. The first 10 points you get for free.

| Excercise | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| Points | 10 | 10 | 10 | 10 | 12 | 8 | 10 | 10 | 10 |

Always explain your answers. Good luck!

1. First-order logic (FOL) is more expressive than propositional logic (PL).
   (a) Explain what it is, that can be expressed in FOL, but not in PL.
   (b) Under certain conditions, the role of first-order quantifiers can be simulated in propositional logic. Explain what the conditions are and how the simulation works.

2. Translate the following geometric assertions into First-Order Logic. Use a membership predicate to express relations between geometric objects. So, use the membership predicate to denote that points belong to lines, planes, circles, etc. and to denote that lines or circles belong to certain classes of lines or circles, etc. You can use constructions like "#corners(obj) = 3" to express that "obj" has 3 corners.
   (a) If two planes have a point in common, there is another point they have in common.
   (b) A pyramid has five corners if and only if it has four sides that have one point in common.

3. Two well-known problems with the logic representation of actions are the *frame problem*, and the *qualification problem*.
   (a) Explain these problems briefly.
   (b) Russell and Norvig describe a solution to the representational frame problem in the situation calculus. Explain the idea behind this solution, using an example and (if you can) formulas.

4. (a) Explain the difference between a green and a red cut.
   (b) What will be the result if the following Prolog program is asked whether **d** is a scsi drive?

```
drive(d).
scsi_drive(X) :- drive(X), not(ide_drive(X)).
ide_drive(X) :- drive(X), not(scsi_drive(X)).
```

5. A palindrome is a word that reads the same in reverse direction. Examples are `['l','e','p','e','l']` and `['p','a','r','t','e','r','e','t','r','a','p']`. Blackburn gives the following program to check if a word is a palindrome:

```
palindrome(List) :- reverse(List,List)
```

   There are also solutions not using **reverse/2**. One solution uses recursion and **append/3** (append two lists together to yield a third list). Give this solution. If you cannot do so, but do know how to explain the solution in words, this might also give you some points.

see the other side

6. A planning problem is described using STRIPS in the following way:

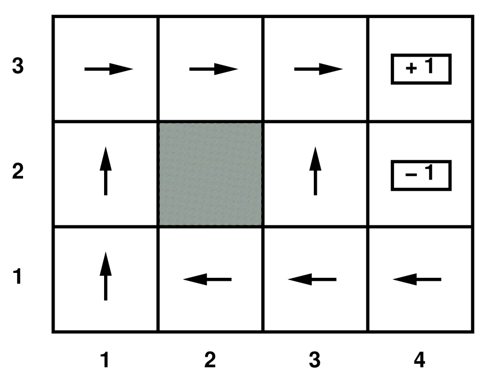
- Initial situation: `A ∧ C ∧ D`
- The goal: `B`
- The actions:

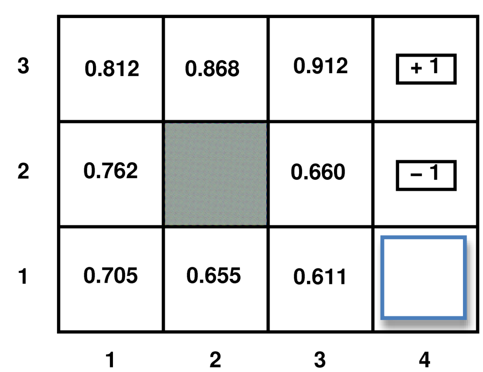
```
Act1                         Act2
PRECOND: D                   PRECOND: A ∧ C
EFFECT: C ∧ ¬E               EFFECT: E ∧ ¬A

Act3                         Act4
PRECOND: C ∧ E ∧ F           PRECOND: D
EFFECT: B                    EFFECT: F ∧ ¬C
```

(a) Solve this planning problem.
(b) Mention the restrictions of the STRIPS representation formalism.
(c) STRIPS uses the Closed World Assumption. Explain for each of the aspects ‘initial situation’, ‘goal’, ‘precondition’ and ‘effect’ of a STRIPS description whether or not STRIPS assumes the CWA or not.

7. (a) Describe and explain the most important points for backtracking in the HTN planning algorithm
(b) HTN planners are often used in case the application requires one to give explanations for chosen actions. Explain why HTN is the right choice for such application domains.

8. Below two pictures from the book concerning an optimal policy for a Markov decision process where the (dis)reward in each non-terminal state is -0.04. The left picture shows the optimal policy when the chances that as a result of an action one ends up in the room one is heading for are 0.8, and the chances that one ends up in a room to the left or to the right are 0.1 for both possibilities. Bumping into a wall means that one stays in the same room. The rooms with rewards +1 and -1 are terminal states. The right picture shows the utilities associated with the states, for the optimal policy of the left picture.
(a) The utility in (4.1) is not shown. Calculate it on the basis of the information that you do have.
(b) In what way do we have to adapt the dis-reward in order to let the agent decide in (3.1) not to take the ‘detour’ via (1,1) and (1,3)?




9. In Inductive Logic Programming definitions for predicates are learned.
(a) Explain the link with resolution steps for standard first-order logic.
(b) What is the main advantage and what is the main drawback of Inductive Logic Programming?