Exercise 2

Foundations of Agent Programming

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International Master Program in Computational Logic — summer term 2009

30.04.2009

Exercise 2.1

Consider the GDL specification of precondition axioms (Slide II/34) and effect axioms (Slides II/35 and II/36) in the game *Tic-Tac-Toe*. Translate these axioms into the General Action Calculus, formulating exactly one precondition axiom and exactly one effect axiom.

Hint:

Define an action $JointMove(xaction, oaction)$ such that the variable $xaction$ ($oaction$, resp.) stands for the action of the xplayer (oplayer, resp.).

For example, $JointMove(Mark(1,1), Noop)$ expresses that xplayer marks field $(1,1)$ while oplayer does nothing.

Exercise 2.2

Reconsider the Blocks World domain from Exercise 1.2, where we used the following fluents and actions:

$Clear(b)$	$\hat{=}$	block b is a topmost block
$On(b_1, b_2)$	$\hat{=}$	block b_1 is directly on Block b_2
$Table(b)$	$\hat{=}$	block b is on the table
$Stack(b_1, b_2)$	$\hat{=}$	Put block b_1 from the table to the top of block b_2
$Unstack(b_1, b_2)$	$\hat{=}$	Put block b_1 from the top of block b_2 to the table

Solve the following tasks in the General Action Calculus:

a) Specify precondition and effect axioms for the two actions.

b) Given the initial state axiom

$$Holds(f, S_0) \equiv f = On(A, B) \vee f = Clear(A) \vee f = Table(B),$$

determine the state formula after performing the actions $Unstack(A, B)$ and $Stack(B, A)$. Justify your answer using the initial state axiom together with the axioms from exercise a).

c) Consider the initial state axiom from b) together with the following GOLOG program δ_{blocks} :

$$\begin{array}{l} \textbf{if } (\exists b_1, b_2)\ On(b_1, b_2) \\ \quad \textbf{then } \pi b_1 . \pi b_2 . Unstack(b_1, b_2) \\ \quad \textbf{else } \pi b_1 . \pi b_2 . Stack(b_1, b_2) \\ \textbf{endIf} \end{array}$$

Verify that after successfully executing δ_{blocks} twice starting in the initial situation S_0 , there is a block which is on another block. More formally, show that the following holds:

$$(\forall s_1, s_2)\ [DO(\delta_{blocks}, S_0, s_1) \wedge DO(\delta_{blocks}, s_1, s_2) \supset (\exists b_1, b_2) Holds(On(b_1, b_2), s_2)].$$