Integrative Modelling 2 – Exam 24-03-2010

The time available for completing this exam is 2 hours and 45 minutes. The final grade for the exam E will be calculated as follows: E = (S+10)/10, where S is the sum of the points obtained for the individual questions. The overall grade for the course G is calculated as follows: G = (E + H) / 2 where H is the average grade for the homework assignments. Note that the average is only calculated in case E ≥ 5; otherwise G = E.

Part 1 - Theoretical Questions (45 pts)

Answer the following questions:

a) Give four examples of concepts that are usually used to model processes at the cognitive level. **(5)**

b) Explain the *Hebbian learning principle* and provide a formal specification of this principle. **(10)**

c) Describe the four different types of interlevel-relations that can be established to relate models at different levels of the process abstraction dimension to each other. **(5)**

d) A specific case of a temporal interlevel relation can be applied when both the temporally higher level and lower level model are executable (for example specified in LEADSTO). In this case the *behaviour* of the higher level model can be related to the *behaviour* of the lower level model. Explain in three steps how this can be done. **(5)**

e) Suppose that a numerical approach is used for modeling a process at a global cluster level; what do the numbers used for the global cluster level concepts represent? **(5)**

f) What are the basic elements of a temporally local specification of a dynamic property at the global cluster level? **(5)**

g) What are the two main mechanisms required to specify relations between the individual agent level and the agent cluster level? **(10)**

Part 2 - Practical Case Study (45 pts)

Consider a domain model for trust, which is described by the following five dynamic properties:

Dynamic Property 1

$\forall A_i$:AGENT, E:EXPERIENCE, A:AGENT
communication(A_i, E, A) $\rightarrow$ belief(A, exp(A_i, E))

Dynamic Property 2

$\forall$A, A_1, .., A_n:AGENT, E_i:EXPERIENCE, TR_1, .., TR_n TRUST_VALUE
belief(A, exp(A_i, E_i)) & trust(A, A_1, TR_1) & .... & trust(A, A_n, TR_n)
$\rightarrow$ trust(A, A_i, TR_i + (β*(E – TR_i + η*(TR_i - $\sum_{j=1}^{n} TR_j / n$)) – γ*TR_i)*Δt)

Dynamic Property 3

$\forall$A, A_1, .., A_n:AGENT, TR_1, .., TR_n TRUST_VALUE
trust(A, A_1, TR_1) & ..... & trust(A, A_n, TR_n) & TR_i > TR_1 & ... & TR_i > TR_n & desire(A, select_most_trusted)
$\rightarrow$ intention(A, select(A_i))

Dynamic Property 4

$\forall$A, A_i:AGENT, TR_1, .., TR_n TRUST_VALUE
intention(A, select(A_i)) $\rightarrow$ communication(A, give_exp, A_i)

Dynamic Property 5

$\forall$A:AGENT
desire(A, select_most_trusted) $\rightarrow$ desire(A, select_most_trusted)

a) Explain the location of this domain model in the 3D classification scheme of domain models. **(5)**

b) Describe the working of the formal model as presented above in an informal manner. **(10)**

c) Express two formal properties of a model on the same agent cluster and process abstraction level but on a different temporal level. The two properties you distinguish should each be of a different type (whereby the property types can be achievement property, equilibrium property, maintenance property, time comparison property, trace comparison property, backward representation relation, forward representation relation). **(10)**

Now consider one dynamic property of another model for trust:

Dynamic Property 6

$\forall\gamma, t, A, A_1, \ldots. A_n, TR_1, \ldots., TR_n, E_1, \ldots. E_n$
$[\ A_1 \neq A_2 \ \& \ \ldots \ \& \ A_{n-1} \neq A_n \ \&$
$\ \ state(\gamma, t) \models communication(A_1, E_1, A) \ \& \ \ldots..\ \&$
$\ \ state(\gamma, t) \models communication(A_n, E_n, A) \ \&$
$\ \ trust(\gamma, t, TR_1, A_1) \ \& \ \ldots..\ \&$
$\ \ trust(\gamma, t, TR_n, A_n) \ \& \ TR_i > TR_1 \ \& \ \ldots \ \& \ TR_i > TR_n$
$\Rightarrow \ state(\gamma, t + 4) \models communication(A, give\_exp, A_i)$

Where

trust(γ:TRACE, t:TIME, TR_i:REAL, A_i:AGENT) ≡

$[\ t = 0 \Rightarrow TRi = 0] \ \&$
$[\ t > 0 \ \&$
$\ \forall TR_{12}, \ldots., TR_{n2}, A_1, \ldots., A_n, E$
$\ [\ A_1 \neq A_2 \ \& \ \ldots \ \& \ A_{n-1} \neq A_n \ \&$
$\ \ trust(\gamma, t\text{-}1, TR_{12}, A_1) \ \& \ \ldots. \ \& \ trust(\gamma, t\text{-}1, TR_{n2}, A_n) \ \&$
$\ \ state(\gamma, t) \models communication(Ai, E, A) \ \Rightarrow$

$$TR_i = TR_{i2} + (\beta^*(E - TR_{i2} + \eta^*(TR_{i2} - \sum_{j=1}^{n} TR_{j2}/n\ )) - \gamma^*TR_{i2}\ )^*\Delta t\ ]\ ]$$

d) Explain the location of this domain model in the 3D classification scheme of domain models. **(5)**

e) Give an accurate and precise natural language description of Dynamic Property 6. **(5)**

f) Explain in your own words how the first domain model introduced above (i.e., Dynamic Property 1-5) can be related to the second domain model (i.e., Dynamic Property 6). **(10)**