Integrative Modelling 2 – Exam 25-03-2011

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 - Practical Case Study (45 pts)

Consider a domain model for depression, which is described by the following three dynamic properties:

Dynamic Property 1
at any point in time,
if the previous number of initiated events is IE
and the current social skills are Sk_1,
and the current availability of events is Av_1
and the current number of potential events is PE_1
and the previous social skills are Sk_2,
and the previous availability of events is Av_2
and the previous number of potential events is PE_2
and the number of reactions is R
then the new number of initiated events will be
$(Sk_1 * Av_1 * PE_1) * (IE / (Sk_2 * Av_2 * PE_2)) * \beta * (1 + R * \gamma) * (((Sk_2 * Av_2 * PE_2) - IE) / (Sk_2 * Av_2 * PE_2))$

Dynamic Property 2
at any point in time,
if the number of initiated events is IE
and the feedback rate is Fr,
then the number of reactions R is (IE * Fr)

Dynamic Property 3
at any point in time,
if the number of initiated events is IE
and the usual hours of sleep is US,
and the sensitivity for sleep symptom is Ss,
then the hours of sleep S is US + (IE * α * Ss)

a) Explain the location of this domain model in the 3D classification scheme of domain models. **(5)**
b) Explain in what sense Dynamic Property 1 is different from most other properties at this location in the classification scheme. **(5)**
c) Describe the working of the semi-formal model presented above in an informal manner. **(10)**

Now consider two dynamic properties of another model for depression:

Dynamic Property 4

∀γ:TRACE, t:TIME, R1, R2, R3, R4:REAL
[[∀t':TIME [state(γ, t') |= has_value(coping_factor, R1) & R1 ≥ AVERAGE_COPING &
state(γ, t') |= has_value(diatheses_factor, R2) & R2 ≥ AVERAGE_DIATHESES] &
state(γ, t) |= has_value(objective_situation, R3) & R3 < AVERAGE_SITUATION &
∀t'':TIME > t + MAX_DUR, R4:REAL
[state(γ, t'') |= has_value(objective_situation, R4) & R4 > AVERAGE_SITUATION]]
⇒ ∀t2:TIME > t [¬depression(γ , t, MIN_DUR, MAX_LEVEL)]]

Dynamic Property 5

∀γ:TRACE, t1, t2:TIME, R1, R2, R3:REAL
[[state(γ, t1) |= has_value(objective_situation, R1) &
state(γ, t2) |= has_value(objective_situation, R1) &
state(γ, t1) |= has_value(thoughts, R2) &
state(γ, t2) |= has_value(thoughts, R3) & R2 < R3]
⇒ ∃R4, R5 :REAL, D:integer < MAX_DELAY
[state(γ, t1+D) |= has_value(subjective_situation, R4) &
state(γ, t2+D) |= has_value(subjective_situation, R5) & R4 < R5]]

Where:

depression(γ:TRACE, t:TIME, MIN_DUR:INTEGER, MAX_LEVEL:REAL) ≡
∀t2:TIME > t [t2 < t + MIN_DUR] ⇒ [∃R:REAL state(γ, t2) |= has_value(mood, R) & R < MAX_LEVEL]

d) Again, 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 4. **(5)**
f) Describe which type Dynamic Property 4 and 5 are (whereby the property type can be achievement property, equilibrium property, maintenance property, time comparison property, trace comparison property, backward representation relation, forward representation relation). Motivate your answer. **(5)**
g) Explain in your own words if and how the first domain model introduced above (i.e., Dynamic Property 1-3) can be related to the second domain model (i.e., Dynamic Property 4 and 5). What should be done? **(10)**

Part 2 - Theoretical Questions (45 pts)

Answer the following questions:

a) Explain what a *threshold function* $th(\sigma, \tau, V)$ (with steepness σ and threshold τ) is and how it can be used in neural modelling. **(10)**
b) Give four examples of concepts that are usually used to model processes at the cognitive level. **(5)**
c) There are four different types of interlevel relations that can be established to relate models at different levels of the process abstraction dimension to each other. Describe what these four different types are and illustrate each of them by means of an example from the domain of trust models at different process abstraction levels. **(10)**
d) Give three reasons why it could be useful to establish interlevel relations between models. **(10)**
e) Explain how interlevel relations can play a role within an Ambient Agent that supports humans in their task. **(5)**
f) 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)**