Modelling Cognitive Dynamic Units of Analysis

Vaccari Erminia (email: vaccari@di.uniba.it)

Dipartimento di Informatica, Universita' di Bari, Bari,Italy

D'Amato Maria (email: damato@di.uniba.it)

Dipartimento di Informatica, Universita' di Bari, Bari,Italy

Abstract Poster

We outline a new approach (Vaccari, 1998; Vaccari, 1998a) to cognitive modelling developed in the Dynamic System Theory (DST) paradigm. It is based on structured models representing a set of interacting functional systems (Vaccari, 1998) amenable to be formally represented by independent generative models which are solved simultaneously taking into account their interactions (Delaney & Vaccari 1989). These generative models may be specified at a 'mathematical level' with different (continuous/discrete) formalisms, while at the implementation level we use the discrete event formalism, which allows different time scales and can represent practically any continuous time/discrete time model. Conceptualising systems as structured models refers to the process of structuring models (i.e. using composition) from a conceptual point of view and not simply at the implementation level by means of mathematical artifices. A global functional system (whose invariant activity emerges from the interplay of the activities of its functional subsystems) is formally represented by a structured DST model

In our approach the problem of descriptive complexity affecting the dynamic approach to cognitive modelling (Port & Van Gelder, 1995) is overcome by adopting complementarity of holism and reductionism in the formulation of the structured model. It is also possible to represent in the model hierarchical relations not foreseen by classical DST formalisms.

We show how the above mentioned notion of functional system, characterized by its invariant activity, is conceptually equivalent to a Cognitive Dynamic Unit of Analysis as defined by Mandelblit and Zachar (1998). We also point out that some of the foreseen (type 3 and type 4) forms of unity are not representable by classical dynamic models while they can be easily accomodated in our approach. which foresees also more sophisticated forms of unity. This is possible because our modelling framework foresees representing various different types of hierarchical systems including anticipatory systems governed by feed-forward mechanisms, systems characterized by constitutive hierarchy i.e. connections between a functional system and its constitutive lower level functional systems and by authority hierarchy. i.e. connections which represent authority whereby certain subordinate functional systems are controlled by a higher level functional system.

The generative models constituting a DST structured model can be structured models themselves and it is possible to recursively define higher order structured models. This possibility to represent a sub-model, in turn, as a structured model allows hierarchical representations in a well established theoretical framework such as systems theory. This issue is very important because it assures a correct time synchronization among system activities/events, very difficult to implement in hybrid dynamic approaches based on heuristics.

Our approach has been implemented in a software environment for the formulation and solution of structured dynamic models characterized by modularity and hierarchy (Vaccari, D'Amato & Delaney,1998).

References

Delaney,W. & Vaccari,E. (1989). *Dynamic Models and Discrete Event Simulation*, Marcel Dekker, N.Y.

Mandelblit, N. and Zachar, O. (1998). The Notion of Dynamic Unit: Conceptual Developments in Cognitive Science, *Cognitive Science,* **22**, 229-268.

Port, R. F. and Van Gelder, T.(1995). It's about time: an overview of the dynamical approach to cognition. In Port, R.F. and Van Gelder, T.(eds.), *Mind as Motion,* 1-43,MIT Press, Cambridge, MA.

Vaccari, E.(1998). Knowing as Modelling, *Cybernetics and Human Knowing,* **5**(2),59-72.

Vaccari, E.(1998a). Some Considerations on Cognitive Systems Modelling. In Trappl, R.(ed.), *Cybernetics and Systems'98,* vol.2, 663-668,Austrian Society for Cybernetic Studies, Vienna.

Vaccari, E., D'Amato, M., Delaney, W.(1998). Hierarchical Modelling: a systemic framework, *Third International Conference on Emergence, August 98, Helsinki.* In Farre, G. and Oksala, T. (eds.),*Acta Polytechnica Scandinavica,*.179-184.