Drag and Drop Cognition: Graphical User Interface for Cognitive-affective Models in Multi-agent Systems

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ABSTRACT

We present a newly developed graphical user interface, which allows researchers to create models of complex societal decision-making in a user-friendly manner without being required to program. The software tool is based on InnoMind, an agent-based model that implements theories of emotional cognition from cognitive science. We show the current work in progress and outline the near-term goals of the software development project.

Keywords: Graphical user interface, cognitive-affective mapping, agent-based modeling software, parallel constraint satisfaction, cognitive architecture

1. INTRODUCTION

In recent years, agent-based simulation models are increasingly used from researchers in economics, sociology, or political sciences to study emergent social phenomena resulting from multiple interactions and decisions of individual agents (e.g. Chen, Zheng, & Tan, 2015; Helbing, Yu, Opp, & Rauhut, 2014; Homer-Dixon et al., 2013). Theorists from cognitive science and psychology, however, repeatedly have criticized the over-simplification and empirical inaccuracy of human-decision models employed in many of these social simulations (e.g., Sobkowicz, 2009; Sun, 2007). Considering the inherent complexity of many cognitive-affective models and architectures, the formalization of psychologically realistic decision model remains a central challenge for agent-based modelers – in particular for researchers not trained as cognitive scientists. Software tools such as EMPATHICA (Thagard, 2010) facilitate the development of psychologically more realistic cognitive systems by using a graphical drawing technique called cognitive-affective mapping. The method is based on the logic of localist connectionist networks, which represent individuals' belief systems as interconnected sets of concepts, beliefs and emotions. These visualized mental representations (i.e. cognitive-affective maps, in short CAMs) can be also converted by the software into a computational neural network model of emotional cognition, called HOTCO (for HOT COherence) (Thagard, 2006). Yet this user-friendly technique is not available for multi-agent systems. In our current research, we seek to extend this approach by developing a new graphical user interface enabling the generation of CAM-based agent populations, embedded in the agent-based modeling (ABM) software InnoMind (Wolf et al., 2015; Schröder & Wolf, under review).

2. AGENT ARCHITECTURE INNOMIND

InnoMind (for *Inno*vation Diffusion through Changing *Mind*s) was developed to study attitudinal dynamics in social systems within the context of sustainable transport (Wolf et al., 2015). The agent's cognitive architecture in this ABM is based on the above-mentioned theoretical framework and computational model of emotional cognition HOTCO, a parallel constraint satisfaction model for decision-making. HOTCO models mental representations as nodes signifying important concepts (i.e. needs) and propositions (i.e. actions) and links representing positive or negative relationships (i.e. cognitive beliefs) between the concepts. Additionally, each concept in the network is associated with an affective valence node to model the emotional influence on agent's attitudes. Using a connectionist constraint-satisfaction algorithm (Thagard & Verbeurgt, 1998), InnoMind computes for every agent's architecture a set of attitudes towards different transport modes (for details see Wolf et al., 2015).

Despite its specific focus and empirical grounding in the transport domain, the generic structure of InnoMind provides a flexible framework to adapt the psychologically plausible agent architecture to model the societal dynamics of belief systems in general (cf. Homer-Dixon et al., 2013). However, such endeavours required in the previous version of the model extensive programming skills in Java.

3. GRAPHICAL USER INTERFACE

To facilitate the adaptation of the artificial neural-network models of agents in InnoMind, we are currently developing a new web-based graphical user interface. With this tool we intend to enable users to create cognitive architectures for individual agents as well as agent (sub-) populations in a user-friendly drag-and-drop manner. To serve different purposes of modelers, the software provides an automatic as well as a manual setup mode of agents. In the automatic mode appropriate (empirical) data can be used to generate agent parameterizations. In the manual mode, mental representation of (individual) agents can be drawn manually via the interactive web-browser tool VISMind.

Figure 1 (A and B) illustrates the two basic steps required to manually construct a connectionist model of an agent's belief system. First (Fig. 1A), node setup comprises i) defining the main concepts (i.e. needs, goals and actions) of the agent (-group), each represented by a node, ii) defining the emotional valence of each concept as negative, neutral or positive, iii) specifying the importance of each concept. In the second step (Fig. 1B), the link setup, interconnections between nodes are drawn to represent the relations between concepts. The definition of whether concepts are supportive, neutral or conflictive can be performed in a drag-and-drop manner in the concentric circles of the interface. Finally, in the overview mode (Fig. 1C) the plausibility of the resulted cognitive architecture can be confirmed by visual inspection, multiplied for a certain number of agents and hence converted into computer code.

The software is currently under development and a first component of a more complex visualization and analysis instrument of the agent-based software InnoMind. Continuing this line of work, we hope to further advance the accessibility to agent-based modeling, in general, and to link agent decision models closer to reality, in particular.

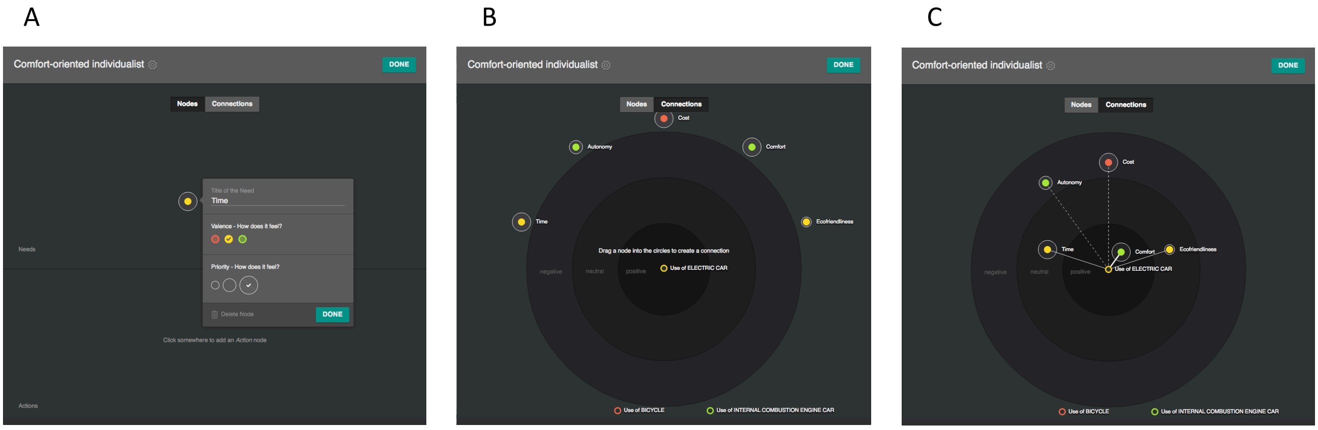

Fig. 1: Graphical user interface VISMind to generate cognitive-affective maps (CAMs) in InnoMind. A) Screenshot of GUI: Creating and setting of nodes (i.e. cognitive and affective representations of concepts), B) Creating links between nodes (i.e. relations between concepts), C) Overview of complete CAM for a specific agent-type.

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