Proceedings of the 2015 Winter Simulation Conference
L. Yilmaz, W. K V. Chan, I. Moon, T. M. K. Roeder, C. Macal, and M. Rosetti, eds.

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SOCIAL SIMULATION FOR ANALYSIS, INTERACTION, TRAINING AND COMMUNITY AWARENESS*

ABSTRACT

Social simulation often concerns the behaviour of humans interacting within some system. Simulation applications are increasingly requiring more realistic and complex human modelling, than reactive rules. We suggest that the established Belief Desire Intention (BDI) approach to modelling cognitive agents, can usefully be applied to modelling humans in social simulations. Traditional social science resources can be used to develop models of human decision making and behaviour that can be represented directly in the BDI programming paradigm. Coupling BDI systems with Agent Based Modelling and Simulation (ABMS) systems, one can create powerful simulations that can be used for a range of analysis, training and community education purposes.

1 INTRODUCTION

Simulation of various kinds is used to develop analysis and understanding in a wide range of domains. Often these domains are inherently concerned with *social* simulation – the behaviour of people interacting within some system. This paper builds on our previous work coupling BDI systems to agent based simulations (Padgham, Scerri, Jayatilleke, and Hickmott 2011), discussing how to model the humans using BDI and how this can facilitate interaction for analysis and understanding in the context of training personnel and in community education. We illustrate with an example of an interactive bushfire evacuation application which we have developed.

The BDI representation consisting of goals, plans and beliefs, supports greater complexity and structure than can easily be captured using reactive rules, while at the same time being simple enough to be comprehensible for domain experts and social scientists. Due to the level of abstraction available, it has also been demonstrated to be highly efficient for building complex applications.

A BDI program is essentially a collection of plans, relevant to particular goals. This can be represented as a goal-plan tree as shown in Figure 1 – part of the design of a simple resident agent in a bushfire situation. This is basically an AND/OR tree where goals link to plans, one of which must be chosen (OR), and plans link to (sub)goals/actions, all of which must be accomplished (AND) to succeed. The context condition of a plan specifies when it is a good choice. This representation enables the agent to be both responsive to the environment, and goal directed over a period of time.

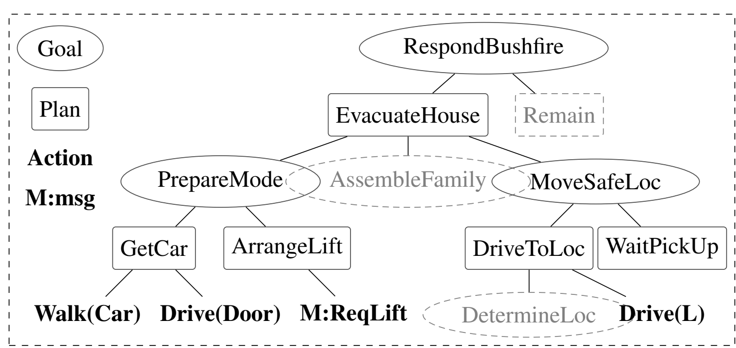

Figure 1: Example BDI goal-plan hierarchy for a resident agent in the bushfire situation

*Thanks to ARC (DP1093290), Telematics Trust (2013, 2014), NCCARF (EM1105) for funding; AOS for use of JACK^{TM}; and Daniel Kidney, Oscar Francis, Todd Mason and Sewwandi Perera for work on program development.

2 MODELLING THE HUMANS WITH BDI

The modelling task requires the following key steps: (i) identification of agent types and attributes. (ii) identification of key goals and ways of achieving them for each agent type. (iii) identification of agent beliefs/knowledge. The collection of data for the model is a standard part of domain modelling in ABMS. However, the relatively direct mapping to a user friendly representation, at an appropriate level of complexity, which then maps directly to code, is a major advantage. We have found it effective for a programmer/modeller to develop the goal plan trees and then refine these together with domain experts. Goals and plans are defined based on the collected information, with the data on what the agent observes and knows informing choices as to what to do (which plan to choose in order to accomplish some goal/subgoal). Observations can also trigger instantiation of goals. For example a higher warning level may trigger a goal to prepare to evacuate.

To incorporate the BDI agents we believe it is advantageous to use an existing BDI programming environment, coupled with an agent based simulation platform. We have developed a generic framework to support coupling of any BDI system with any ABMS, providing a system layer is developed to accumulate and distribute information about percepts and actions as required by the framework. We have developed the system layer for three BDI systems and five ABMS systems[1].

3 INTERACTIVE SIMULATION: BUSHFIRE EVACUATION EXAMPLE

It is well established that experiential learning is far more effective than simply reading or being told. An interactive simulation that allows a user to control the decisions of one of the agents can be a powerful tool for a user to practise making complex decisions as a situation develops.

Because BDI program code is implemented at the level of goals, beliefs and plans it is possible to provide generic infrastructure that will allow user interactions to view and even control agent states. There are three basic ways a user can interact with the BDI simulation during execution: (i) by examining the specific actions and beliefs of an agent, either by pausing the simulation, or dynamically as it runs; (ii) by specifying breakpoints at any goal, in order to pause the execution and manually choose which plan should be executed; and (iii) by modifying agent beliefs (which will affect what plan choices are available and chosen).

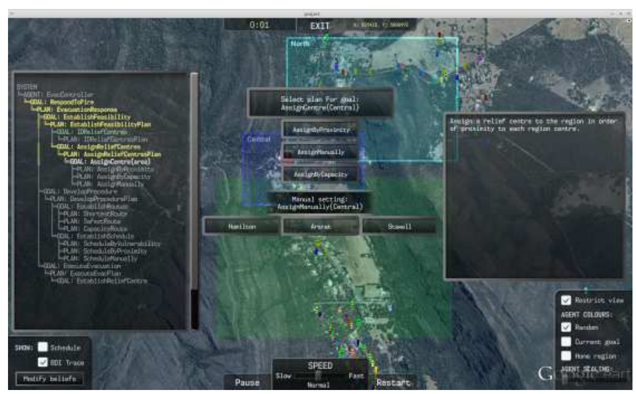

Figure 2: Incident Controller interaction in Hall's Gap evacuation scenario

Figure 2 shows the interface in an evacuation scenario, developed to demonstrate through a prototype the potential for use of interactive simulation by emergency services personnel. It can be used for exploration and for training of, for example, incident controllers as in this example, or also for community education. In our study of the use of an interactive simulation for getting across key messages, we found that this was more effective than print media.

REFERENCES

Padgham, L., D. Scerri, G. Jayatilleke, and S. Hickmott. 2011. "Integrating BDI reasoning into agent based modeling and simulation". In *WSC'11, Phoenix, AZ, USA, December 11-14, 2011*, 345–356.

[1]integration code and example applications are available at http://tiny.cc/bdi-abm-integration.