1 Context

The state of Victoria in Australia is frequently confronted to bushfires of varying seriousness. Despite great efforts at raising awareness of the population, in February 2009 dramatic bushfires cost 173 lives. A commission was created to investigate and concluded that the responsibility was shared by all actors: emergency managers (firemen, police...) assumed the population would follow instructions and prepare a fire plan in advance, so during fires they only broadcast generic alert messages advising them to follow that plan; on the contrary, many residents did not have a plan ready and preferred to wait until the last moment to evacuate, therefore feeling helpless and lacking more precise advise from the authorities.

In that situation, agent-based simulation and serious games based on that simulation offer an efficient tool to raise the population’s awareness about best behaviours, allow them to train in advance, but also to let deciders test strategies and collect information about the population’s behaviours and decisions in bushfires without having to wait for a real event and casualties. Agent-based modelling and simulation have indeed already been used for decision-support in crisis situations.

However, the lack of realistic data limits the validity of results. We need to build a spatial simulation based on real data coming from multiple sources (GIS, surveys, field studies, interviews, etc) that need to be integrated in the model. Besides, existing simulations are often based on simplistic agents (particles, reflex architectures, finite state machines...) so we need to design a realistic cognitive architecture for the agents representing the different actors involved. Finally, in order to engage the deciders and to operationalise the results, the behaviour model will be transformed into a serious game, with two applications: raising the population awareness, and informing and supporting emergency managers’ decision making.

2 Scientific problems

In this PhD we want to answer three scientific problems:

• the applicability of BDI agents in agent-based social simulation: available methodologies and tools, optimisation for large scale simulations;
• integration of real data from multiple sources, in order to guarantee the validity of the simulation results;
• using the serious game to collect behaviour data to inform deciders and crisis managers; methods for collecting and representing such data, determining relevance and validity.

3 Planning

The SWIFT project is divided in 6 work packages: 1) behaviour data collection and analysis; 2) conception of the multi-agent based spatial model of population behaviour; 3) design of a cognitive architecture adapted to agent-based social simulation; 4) contribution to the BDI architecture for the GAMA platform and implementation of the behaviour model in GAMA; 5) transformation into a serious game; 6) publishing and promoting the results.

The first year of the PhD will be dedicated to the state of the art and training of the student (summer school, for instance MAPS), then to the analysis of data (WP1) to elaborate a first behaviour model (WP2), and to the design of a first version of the cognitive architecture (WP3). Iterations will happen between the behaviour model and the cognitive architecture to ensure the right level of complexity of agents, in order to realistically simulate the behaviour of actors without adding any unnecessary complexity. The student will be able to use preliminary results of an M2R student who implemented a first model of population behaviour in bushfires. The first results (cognitive architecture, behaviour model) will be published in national conferences.

The second year of the PhD will be dedicated to implementing the model (WP4). The student will start with learning and possibly enriching the BDI architecture of GAMA to enable the specification of agents with the cognitive architecture designed at WP3. He will then use this GAMA to implement the environment model and the agent model as conceived in WP2 and WP3, therefore iteratively improving these models. This implementation will also allow to test possible improvements of the BDI plugin for GAMA before they are published in the next
open source version accessible to a large international community of GAMA users. The implemented model will be tested, calibrated and validated. The results will help in justifying the applicability of BDI agents in social simulations, and will be published in an international conference.

The third year of the PhD will be dedicated to transforming the simulation into a serious game (WP5), experimenting with it, writing the thesis, and publishing and promoting the results. Experiments will be run with the serious game prototype in order to validate its usability with the population and the deciders. Results will be published towards the international scientific community (conferences, journal), while the serious game will also be promoted towards the actors via the organisation of a workshop.

4 Objectives

The objectives of the PhD and the project are threefold:

- Technological: enriching the BDI plugin for GAMA, an open-source simulation platform that is used by several thousands modellers around the world;

- Scientific: new methodology for conceiving models from interviews data; new cognitive architecture for agents with the appropriate level of complexity to capture human behaviour as described in these interviews (emotions, communication, trust, norms...); features of engagement in a serious game based on such a social simulation;

- Societal: providing a realistic generic model of human behaviour that can be adapted and used in various social simulations; providing a serious game that can be used for validating crisis managers’ strategies regarding information broadcast or evacuation, and for training the population to best behaviours in bushfires.

5 Related publications

- C. Adam, B. Gaudou. Modélisation de comportements humains en situation de crise à partir d’entretiens : application aux incendies de forêt de Melbourne. Soumission en cours d’évaluation.

- P. Taillandier, M. Bourgais, P. Caillou, C. Adam and B. Gaudou. A situated BDI agent architecture for the GAMA modelling and simulation platform. MABS workshop @ AAMAS 2016.

