Interactions between Levels in an Agent Oriented Model for Generalisation

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Abstract. Generalisation is a complex operation of the mapping process seeking to simplify geographic data. In order to carry out this process, algorithms are used. Multi-agent systems are an approach to orchestrate the application of these algorithms. Models were proposed in the literature, but some situation are not automatically generalised in a satisfying way. Our hypothesis is that, if the behaviour of the agents is described in a way that takes into account the organisation of geographic objects in levels, we may solve these issues. Methods to explore this hypothesis are introduced in this paper.

Keywords: Cartography, Automated generalisation, Multi-agent systems, Multi-levels.

1 Introduction

The PhD project exposed in this paper deals with cartographic generalisation. Cartographic generalisation is the process that aims at decreasing the level of detail of a vector database to fit a given scale and specific users' needs in order to create a legible map. Indeed, when the scale decreases, the extent on the map to show information about the portion of the real world in reality is smaller (Figure 1).

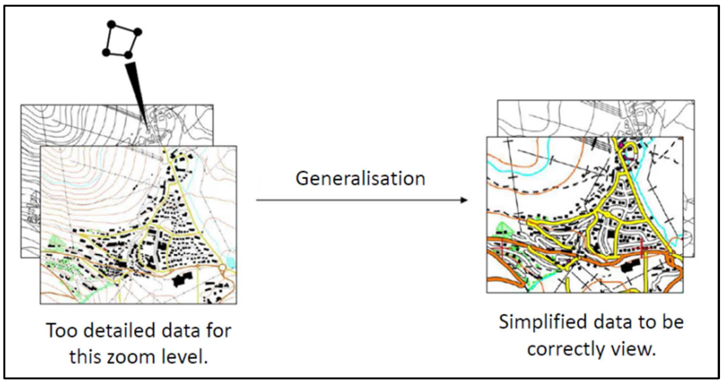

Fig. 1. Generalisation of a detailed map from vector data (copyright IGN).

This is a complex process as the generalisation of different objects (buildings, roads, etc.) is constrained by other objects. Among the different approaches used to automate the process, there are agent-oriented models. These models allow solving some specific issues. We assume that a more generic way to describe relations between objects will help us to generalise automatically more cases. In this position paper we first describe the motivation of the PhD project, then we give research questions and finally we describe our methodology.

2 Motivation

The main idea of the agent oriented generalisation models is the fact than geographic objects are describe as an agent (Weiss, 1999) that attempts to satisfy personal constraint (e.g. minimal size constraint for a building) and shared constraints (e.g. proximity constraint between a building and a road symbol). These autonomous entities will execute interactions with other ones to solve locally issues produced by scale change. An interaction is an operation executed by one or more agent(s) taking into account their situation (Figure 2).

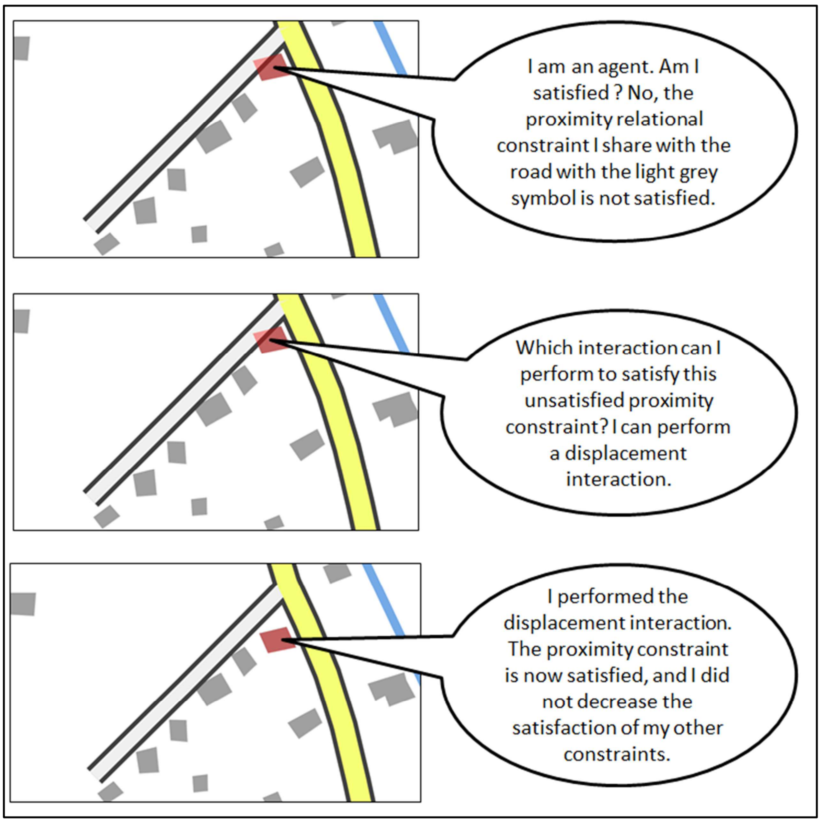

Fig. 2. Simplified scenario of the execution of an interaction (copyright IGN).

Interactions may be hierarchical. In AGENT (Ruas 1999; Barrault et al. 2001), relationships are described between components (e.g. building) and a “meso” object (e.g. urban block), and the meso agents are able to trigger its components and give orders to them. Interactions may occur between objects from same levels too (e.g. two close buildings interact when one moves away from the other) like in the CartACom model (Duchêne 2004; Duchêne et al., 2012). The GAEL model (Gaffuri et al., 2008) introduces new interaction types when decomposing objects into points: the interactions between the decomposed object and its points, and the interaction between the points themselves. The interactions in these three models are showed in Figure 3.

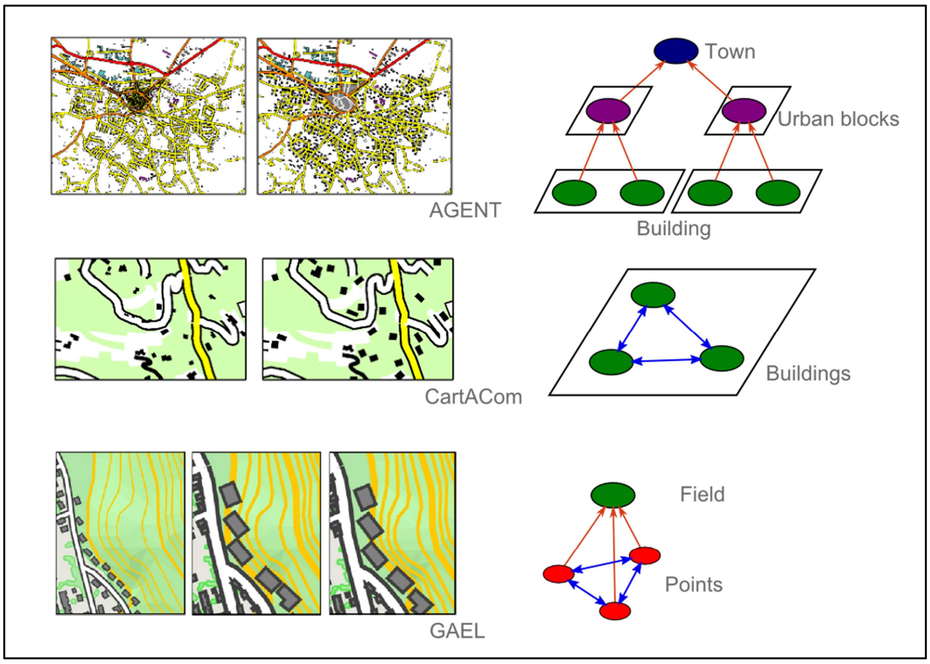

Fig. 3. Interactions between objects in existing models (copyright IGN).

Some problems remain unsolved by these models. Indeed, other types of relations should be used to improve generalisation:

- The inclusion relationship type occurs when an object is included in another object, e.g. accidents or bus stations on a road (Jaara et al., 2012) (Figure 2b).
- Diagonal interactions between objects of different levels, e.g. two buildings interacting as a whole with other neighbouring objects (Figure 2a).
- Objects involved in a hierarchy can both interact with their “parent” and other objects in a same level, e.g. bus stations staying on a road when the shape of the road is modified while preserving consistency with other bus stations (Figure 2b).

– An object can be included in two hierarchical relationships and therefore needs to make decisions taking into account these two relationships at the same time, which is currently not well handled, e.g. a building belonging to two alignments (Figure 2c) or a bridge included both in a road and a river (Figure 2d).

We assume that a generic interaction model would help to solve these issues. A model used in the simulation domain called PADAWAN (Picault and Mathieu, 2011) has interesting properties for the issue (e.g. multi-level hierarchy, interaction-based model).

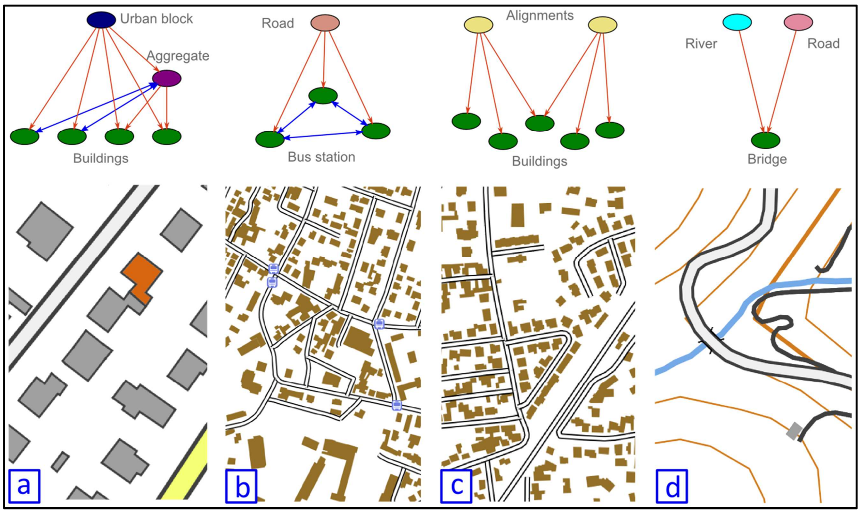

Fig. 4. Instances of relation types not processed yet (copyright IGN).

3 Aims and research questions

The objective of the PhD is to define an agent-oriented generalisation process taking into account relations between objects at different levels and to answer to those research questions:

– How can generalisation problems implying many levels of interaction be solved? The main purpose of the PhD is to provide solutions in order to improve an automatic generalisation process.
– How to orchestrate interactions between agents? The order the agents are activated and the order the algorithms are applied impacts the result of the generalisation. In an agent modelling perspective, we want to provide a generic way of modelling the agent behaviour in constraint solving problems.

4 Method

PADAWAN is identified as a potential basis to solve remaining questions on interactions between agents in generalisation. First, I analysed similarities and differences between this model and the existing ones, in order to adapt PADAWAN to the specificities of generalisation.

Then case study was defined: a map combining base topographic data and touristic thematic information. Figure 3 gives an instance of the case study: a series of bends can be schematised using a schematisation algorithm (Lecordix et al., 1997) that removes some bends (Figure 3a and 3b). But when the bend has a proximity relationship with a touristic point object (Figure 3c), how can this information be preserved? Solutions to such problems will be proposed, and will be evaluated by means of experiments.

From these specific cases I will analyse in a more generic way the relations between objects and then I try to propose a decision process to orchestrate the activation of the agents. This process will have to be evaluated by means of experiments too.

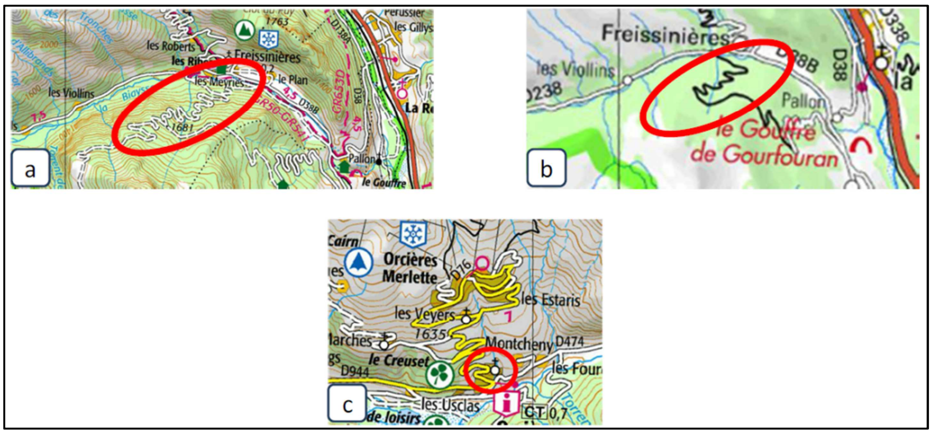

Fig. 5. (a) They are 13 bends between the two junctions of the circled road (1:100k). (b) The same portion gets only 8 bends (1:250k). (c) If we have to apply the same operation, how to preserve bends in relation with other map elements (like the encircled church)? (copyright IGN).

5 Conclusion and perspectives

First, we introduced agent approaches to automate generalisation process and their limitations. Then, we expose our hypothesis: enhance the expression of interactions may help us solve unsolved generalisation case. We identify some of the unsolved case and their multi-levels aspects. Currently, the first results cover two aspects: the adaptation of existing processes to the PADAWAN model and the study of specific cases (Maudet et al. 2013). The next steps will be to give solutions to other specific cases in order to propose a generic way to manage multi-level interactions.

6 References

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