ADELFE Design, AMAS-ML in Action
A Case Study

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Abstract. The complexity of engineers tasks leads us to provide means to bring the Adaptive Multi-Agent Systems (AMAS) design to a higher stage of automation and confidence thanks to Model Driven Development (MDD). This paper focuses on a practical example and illustrates the modifications that have been done to the ADELFE methodology. In the Design phase, we propose to use a Domain Specific Modeling Language (DSML) for the specification of cooperative agents. We also, add a Model Driven Implementation phase using model transformation, DSMLs and code generation. These phases carry out a model centric process to produce and partially generate the system code. We present the use of our MD process applied to a simple, but very illustrative example: the foraging ants simulation.

1 Introduction

Our team works both on adaptation and Multi-Agent Systems, the result is that we propose paradigms to manage adaptation at different conceptual levels. We propose an approach which introduces adaptation following three independent axes [1]. The first one differentiates system level adaptation, achieved according to AMAS principles [2], from agent adaptation, allowed by a flexible agent architecture [3]. The second axis distinguishes functional adaptation (which concerns the system expected functionality, i.e. the service performed) and operational adaptation (which concerns execution mechanisms, i.e. means to perform services independently of the functionality itself). Finally, the third one concerns adaptation time. Adaptation is qualified as dynamic when it occurs at runtime and static when it occurs at design time. As the system is designed to provide a function for the user and that it is responsible for that, system level adaptation deals with means to preserve dynamically the adequacy between the function the system offers and user requirements. Concerning agent adaptation, it is important to notice that, as long as agents execute, they may encounter various operating systems configurations. Therefore, flexible agent architecture is a way of defining and maintaining agent skills up-to-date in order to keep it playing its role.

The combined capacities of these approaches, AMAS principles and flexible agent architecture, enable to deal with systems which can be characterized as complex, due to the complexity of the domain (coupling with the environment, numerous interacting entities) or the one coming from the execution layer. Our proposal is to ease the
design of such systems by combining different adaptation kinds (system/agent, functional/operational) within a tool that would assist the engineers all along the design. This assistant would reduce domain complexity by automating the implementation of the system, letting engineers focus on business concerns. Moreover, complexity of the execution support would be totally hidden thanks to generative tools.

This is the goal of our research, in which we try to combine several software technologies such as reflection, aspect orientation, components, software architectures for implementation issues, as well as AMAS which ease to handle system complexity. In order to make all these technologies cooperate, we use a model driven approach that allows us to integrate modelling and implementation tasks in a common environment, such as Eclipse. All these "good practices’ and principles are specified and gathered in a methodology called ADELFE, which is a development process based on the RUP (Rational Unified Process) and specialised for AMAS developing.

In this paper, we present a practical example of the joint use of both AMAS and flexible agent principles within the ADELFE Design and Implementation phases applied to a simple, but very illustrative example: the foraging ants simulation. The following of the paper is organised as follows. First is presented the context of this paper: section 2 for the ADELFE methodology and its adaptation to a MD approach and section 3 for the case study. Thereafter, the paper focuses in section 4 on the several phases where model transformations and code generations are used. In section 5, we analyse the work presented according to engineers points of view. Finally, we discuss some related works and lastly we conclude.

2 ADELFE 2.0

ADELFE\(^1\) is an agent-oriented methodology for designing Adaptive Multi-Agent System (AMAS)\(^2\). The MAS developed according to ADELFE provides an emergent global function\(^4\). What we call the global function is the function the system is in charge of, whereas what we call local function is one provided by one agent. The global function is qualified as emergent because it is not coded inside the agent. The agents are not aware of this global function. Let’s take the example of the robot transportation application developed with ADELFE\(^5\) where agents have to transport boxes from a room to another one by passing through narrow corridors (agents cannot pass each other). The agents have to move in an environment containing 2 rooms, 2 corridors, boxes, walls, others robots. Each agent’s local behaviour consist in avoiding collision and in trying to be cooperative. Being cooperative means for the agent maximising its utility in the system. Therefore, it tries to avoid situations of concurrency, uselessness, ambiguity and other kind of conflicts. The global phenomena not coded inside the agent is that a traffic direction emerges. To obtain this emergent behaviour, the system follows

\(^1\) ADELFE is a French acronym for "Atelier de Développement de Logiciels à Fonctionnalité Emergente". It was a French RNTL-funded project (2000-2003) which partners were: ARTAL Technologies (http://www.artal.fr) and TNI-Valiosys (http://www.tni-valiosys.com) from industry and IRIT (http://www.irit.fr/SMAC) and L3I (http://www.l3i.univ-lr.fr) from academia. See http://www.irit.fr/ADELFE