

# The KODAMA Methodology: An Agent-Based Distributed Approach

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**Abstract.** The KODAMA methodology is our endeavour to explore new analysis and design methodologies, as well as new tools, for developing ubiquitous applications around autonomous, interacting software agents. To concrete and detail the well-known multiagent system paradigm, KODAMA introduces a plug-and-play agent model, an agent community model and an on-demand interaction model. At the top level, a whole system is decomposed into various agent communities. Working one level down, communities are broken down into independent agents. At the lowest level, agent roles are the basic entities for specifying agent activities in online interactions. In this article, we first present how these new models are exploited in the analysis and design phases; then discuss some details of how they are implemented in a practical shopping-support system.

## 1 Introduction

In an era of *ubiquitous computing* that Mark Weiser foresaw in [1], the new software engineering challenges that must be faced are characterised by three key features. First, most systems are now de facto concurrent and distributed, and are expected to interact in flexible ways to dynamically exploit services and make context-dependent decisions that can not be foreseen at design time. Second, more and more systems are moving towards a customer-centred paradigm, in which many aspects of customer behaviour should be facilitated. Third, and as a natural consequence of the first two features, systems have to be designed as open systems so that new components may join (and existing components may leave) the system constantly, and interactions may occur at unpredictable times, for unpredictable reasons, between unpredictable components [2].

Against this background, the KODAMA (Kyushu University Open & Distributed Autonomous Multiagent) methodology exploits the *multiagent system* (MAS) paradigm to provide a set of new analysis and design models for developing ubiquitous applications. From the micro level to the macro level, KODAMA introduces a plug-and-play agent model, an agent community model and an on-demand interaction model. When taken together, these new models form a complete mapping between the characteristics of complex systems and the key

abstractions necessary for modelling agents, agent organisations and agent interactions. These abstractions in turn serve as clear guidelines for the full system development and maintenance cycle.

Different from other methodologies such as Gaia [3] and ARCHON [4], our approach offers a holistic methodology and software engineering guidance on (i) how to conceptualise and structure applications as agent-based systems, (ii) how to explicitly represent agent social relationships to dynamically form, maintain, and disband organisations, (iii) how to distribute different tasks throughout the community. The emphasis of KODAMA therefore is on the smooth integration of analysis, design, development and maintenance of multiagent systems.

The remainder of this article is organised as follows. Section 2 details the KODAMA methodology as it pertains to agent-oriented software engineering (AOSE). Section 3 examines a case study of a shopping-support system to show some details of its implementation. We then outline, in Section 4, some concluding remarks.

## 2 The KODAMA Methodology

The core concepts behind agent-oriented software engineering, in effect, are agent-oriented decomposition, agent-oriented abstraction and agent-oriented organisation [5,6].

**Agent-oriented decomposition:** the problem-solving space of a system is naturally partitioned into self-contained agents.

**Agent-oriented abstraction:** agents, either cooperating or competing with each other, are the right metaphor for both analysing and modelling subsystems, subsystem components, interactions, and organisation relationships.

**Agent-oriented organisation:** by their very nature, agents are social entities not only in the sense that they need to interact, but in the sense that they rely on others according to protocols determined by their roles.

In the following two subsections and Section 3, we detail how these three concepts are exploited in KODAMA for the analysis, design and implementation of multiagent systems.

### 2.1 The Analysis Phase

The main goal of the analysis phase is to collect and specify the requirements of the system-to-be and to identify some generic characteristics of the system that are likely to remain the same regardless of the actual applications.

Just as the real world can be viewed as a set of autonomous agents that collaborate to perform some higher-level function [7], agent-oriented decompositions based on functions/actions/processes are more intuitive and closer to the way people might think about a problem [8]. Accordingly, the KODAMA approach defines a set of preliminary models of agents, interactions and organisations as follows: