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A Knowledge Oriented Approach for Composing Ambient Intelligence Services

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Abstract

Ambient environments involve a variety of smart devices. Communities of these devices form a ubiquitous information processing system to which the physical environment should provide an intuitive and flexible user interface. Indeed, due to the proliferation of the number of services in ubiquitous environments, the problem of dynamic service composition becomes a complex task.

Our work tries to solve the problem of service composition based on AI planning. The approach used in our framework is based on a temporal reasoning system called Event Calculus. This formalism is used to generate an action plan to a symbolic level from a composition plan described in XML modeling the behavior of the composition of services. Event Calculus has a double interest to propose a solution to the problem of temporal persistence and to provide a usable technique for planning. The framework for service composition using Event Calculus includes mechanism for the service selection, based on an estimation of the reputation for abstract services and the Quality of Service (QoS).

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Keywords: Ambient environments, service composition, AI planning, Event Calculus, Quality of Service;

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1. Introduction

Technological advances in recent years have focused on the democratization of wireless networks and the miniaturization of communication devices**.** Current progress of computer systems lead us to the era of pervasive computing, in which almost all objects in our environment will be equipped with computing and communication capabilities[26]. This trend is likely to increase in the future, especially with nanotechnology and low costs of computers making it feasible to integrate them in practically all items of our daily lives, such as furniture, clothing etc., making these objects smarter and easier to use. Environments equipped with such sensitive and responsive computer nodes are referred to as being ambient intelligent[27]. Ambient Intelligence[28] is considered as the enabling technology for a new generation of systems, which provide their services in a flexible, transparent, and anticipative manner requiring minimal skills for human-computer interaction. Through the paradigm of Ambient Intelligence, the goal is to create environments where intelligent ecosystems help to improve the living environment of the users. The vision of a pervasive environment is assist the user in his tasks without being intrusive, and able to perform the appropriate actions while adapting to environmental conditions and the needs of the user. The vision of a pervasive environment is assist the user in his tasks without being intrusive, and able to perform the appropriate actions while adapting to environmental conditions and the needs of the user. Indeed, if the user requires functionalities and no service is alone-able to provide, it would be necessary in this case to discover and compose available atomic services to meet the request.

This work focuses on the problem of dynamic composition of services in ubiquitous environments based on AI planning. As part of the research in Artificial Intelligence, the reasoning is a subject much studied which plays an important role in the implementation of tools and methods of artificial intelligence. The approach used in our framework is based on a temporal reasoning system called Event Calculus. This system defines very general concepts about time and change (events, periods, temporal clauses), which can represent actions[17].

We present a framework that develops an appropriate representation of a set of actions, using formalized knowledge on the specific technical field. Its target is to generate a plan of action to a symbolic level from a composition plan modeling the behavior of the composition of services. It can also monitor the composition process based on events and variables that can be used to trace the execution process. Therefore, Event Calculus has a double interest to propose a solution to the problem of temporal persistence, and to provide a usable technique for planning. The framework for service composition using Event Calculus includes mechanism for the service selection, based on an estimation of the reputation for abstract services and the quality (QoS) for concrete services presented in[21,22].

The rest of the paper is organized as follows. Section 2 gives a summary of the literature survey on AI planning techniques for the service composition. In section 3, we present the formal approach for modeling and reasoning on actions with a special focus on Event Calculus. In Section 4, we illustrate our framework and show how the Event Calculus can be used to define an abstract composite model from the description XML of composition plan. Finally, Section 5 presents conclusions and future work.

2. Related work

There has been a lot of research around the application of AI planning techniques to the field of service composition[2,3,7,6,5,4,12]. Indeed, AI planning is a central issue of Artificial Intelligence. Its objective is to generate a plan of actions to a symbolic level from an initial state to accomplish a goal. Sirin et al. describe in[5] how Hierarchical Task Network (HTN) planningsystem named SHOP2 can be used with Web Ontology Language for Web Services (OWL-S). They transform OWL-S service descriptions to SHOP2. Generated SHOP2 plan is converted to an OWL-S service which can be executed. Unfortunately, it is not possible to directly express the semantics of OWL based on Description Logic (OWL-DL) using SHOP2 axioms. Therefore using SHOP2's theorem prover directly leads to lose the inferencing capability that an OWL reasoner normally possesses. Furthermore, the size of the data involved in the planning process over Semantic Web will be much bigger than the one encountered in classical planning problems. SHOP2's inferencing capabilities are not satisfactory for the