CAPE : Context-Aware Agile Business Process Engine

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Summary of the presentation

Future developments for enterprise process management must evolve from the current systems based on rigid, workflow based processes into context-aware, agile dynamic structures, which exploit local adaptability. In order to enable this agility, we propose our vision of context-aware business process management based on declarative modeling combined with innovative context management and formal concept analysis. In this presentation, we will describe the foundations and the architecture of a Context-aware Agile business Process Engine (CAPE).

Extended abstract

Capacity to timely discover and to efficiently respond to rapid changes in the environment is a major goal of an enterprise of the future. According to [10][4], a firm's ability to adapt to dynamic environments depends first on the agility of its business processes. Therefore, design and development of new process management systems enabling process adaptation at run time are essential.

Lamport defines a process as a sequence of events occurring in system [7], where each event is triggered by an action. Accordingly, a business process can be seen as a sequence of events triggered by activities of business process actors. The majority of existing methods for business process design follow imperative principles, implying that the order of events is predefined. As a result, all meaningful process events need to be determined and corresponding actions need to be predefined at design time. At run time, processes follow the configured model with limited possibilities to deviate from the predefined scenario.

We define the **first form of business process agility** as a capacity to handle unpredictable sequences of system events. This implies that the order of process activity invocations is defined dynamically, at run time, and depends uniquely on the current situation (process state) rather than on a predefined execution scenario(s). To ensure the first form of agility, we shift the traditional imperative paradigm for process design and exploit declarative principles: we represent a business process as finite state machine (FSM) [9] with a state representing a process situation at a given time and state transitions defining the possible process scenarios. The triggering events specify the underlying process semantics, i.e. conditions for state transitions. The FSM formalism makes the notion of process activity implicit while putting forward activity outcomes, which are modeled as triggering events. Therefore, the declarative process model focuses on "what" needs to be done in order to achieve the process goal and not on "how" it has to be done. This allows us to handle process events whose order of occurrence is undetermined and to define the corresponding handling scenarios at run time.

Within our model, the partial ordering of process activities is determined by the state transition relation. Together with authors of [1] we use the term "navigation" to describe the way a process should be executed. We suggest that, instead of following a predefined execution scenario, a process navigates in the process "state space", dynamically adjusting its path based on the current state, current situation and navigation rules. We design initial navigation rules for process guidance based on Formal Concept Analysis and Galois lattices [2][5]. We specify the resulting process as a set of activities that can be dynamically assembled at run time into one of the (non-forbidden) process scenarios. In general, such process specification can offer infinitely many alternative scenarios and a possibility to deviate from one scenario to another during the execution. Within our approach, process states, triggering events and process activities form a *formal context* and can be analyzed using Galois lattices. Process states and activities can be clustered revealing their conceptual properties: For example, we can determine activities that can be executed (or suggested for execution) under given conditions and with an objective to trigger a desired state transition.

In addition, we define the **2nd form of process agility** as the ability to monitor and manage the process context and to dynamically select and/or alter the execution scenario accordingly. We extend the declarative process specifications with dynamic context models and mechanisms for dynamic context management [3][6]. The context parameters reflect our awareness about external and internal information about the process; they can be observed and measured. Even though context-awareness for business processes is addressed in the literature [8][11], the lack of formalism for context representation and management persists: many of the proposed context models are static (need to be defined at design), incomplete (consider only limited context information) and are often specific to workflow-based processes.

We argue that the number and kind of context parameters may vary from one situation (or process state) to another making it impossible to exhaustively model all required context information within a single (static) context model. The context model, therefore, needs to be dynamically instantiated from an appropriate metamodel according to specific (evolving) context dimensions.

The two forms of agility formulated here aim at relaxing the requirements both for human expertise for a given level of process flexibility and for process rigidity (predefined structure) for a desired level of automation. Declarative approach for process design and use of formal methods enable a set of automated techniques for process analysis and validation based on model checking and theorem proving. Thus, they improve the level of automated user support allowing maximum run time flexibility. Context awareness and formal concept analysis enable automated recommendations and identification of alternatives. Their joint use provides flexible guidance to end users at run time and supports them with an expertise required for the process handling.

Novel combination of declarative modeling principles, dynamic context modeling and Formal Concept Analysis is the main research contribution of this work. Indeed, we have proposed a model and a method for specification of agile business processes based on FSM abstraction and formal concept analysis, and we have extended this model with the dynamic context model.

The architecture for a context-aware business process engine (CAPE) illustrated in Figure 1 summarizes our findings.

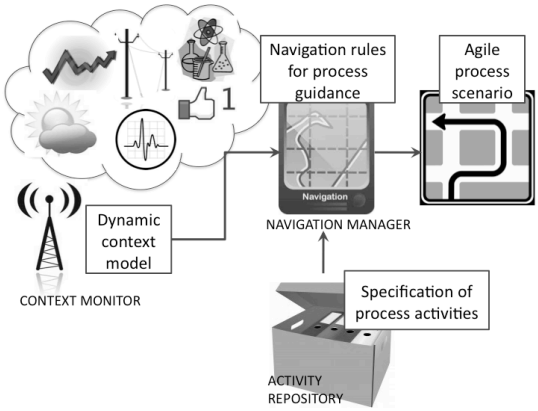

Fig. 1. CAPE architecture: the context monitor, the activity repository and the navigation manager.

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