Chapter 9
Assigning Ontological Meaning to Workflow Nets

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ABSTRACT

A common way to represent organizational domains is the use of business process models. A Workflow-net (WF-net) is an application of Petri Nets (with additional rules) that model business process behavior. However, the use of WF-nets to model business processes has some shortcomings. In particular, no rules exist beyond the general constraints of WF-nets to guide the mapping of an actual process into a net. Syntactically correct WF-nets may provide meaningful models of how organizations conduct their business processes. Moreover, the processes represented by these nets may not be feasible to execute or reach their business goals when executed. In this paper, the authors propose a set of rules for mapping the domain in which a process operates into a WF-net, which they derived by attaching ontological semantics to WF-nets. The rules guide the construction of WF-nets, which are meaningful in that their nodes and transitions are directly related to the modeled (business) domains. Furthermore, the proposed semantics imposes on the process models constraints that guide the development of valid process models, namely, models that assure that the process can accomplish its goal when executed.

1. INTRODUCTION

Process models are widely used to model how an organization conducts its activities to accomplish its goals. In that sense, process models are a widely used type of conceptual models. Process modeling is a complicated task and, hence, error-prone (e.g., Sadiq & Orlowska, 1997; Mendling, 2007). The syntax of process modeling languages specifies how to compose their constructs (which often have graphical notation) into process models. However, syntactically correct process models are not necessarily meaningful in terms of conveying the way the business conducts its activities.

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Moreover, a syntactically correct model might not even be feasible to execute, and even if it is, it cannot always be assured to reach its goal, namely, produce its required outcome. Some meaning can be represented in a process model via the semantics of the modeling language used. These semantics are believed to represent some real-world phenomena, and can be defined textually or mathematically. Either representation may have shortcomings. Textual definitions are typically semi-formal or informal (e.g., "An event is something that "happens" during the course of a business process" (Object Management Group, 2006)), and therefore do not provide representations that are sufficiently precise for formal analysis. In contrast, mathematically-based process representations (e.g., Petri nets (Petri, 1962), YAWL (van der Aalst & ter Hofstede, 2005), Pi Calculus (Milner, Parrow & Walker, 1992)), allow formal analysis and automated verification of models, but their semantics may not be readily associated with the problem domain.

Much effort has been devoted to the formal analysis and verification of process models, leading to methods and tools for analyzing structural properties of process models and for detecting logical problems in them. In particular, Workflow nets (WF-nets)—a special case of Petri nets—have been proposed as tools for modeling the dynamics of processes (van der Aalst, 1998). A Workflow net is a Petri net which (1) has one input place and one output place; and (2) does not contain dangling transitions or places (namely, transitions that might not fire or places that might not be populated). This is equivalent to the net being strongly connected if the output place is interlinked to the input place via an additional transition (van der Aalst, 1998). Workflow nets employ a small set of constructs, yet possess an impressive expressive power and can be used to represent precisely the entire set of workflow patterns (van der Aalst et. al, 2003, Russel et al., 2006).

An extensive body of work exists regarding the mathematical, structural, and behavioral properties of Petri nets, such as free choice, liveness, boundedness and strong connectedness (e.g., Esparza & Silva, 1990; Jensen, 1990; Desel & Esparza, 1995). These properties have been adapted for WF nets, and additional properties (such as soundness, relating to the process dynamics) have been defined (e.g., van der Aalst, 2000). Furthermore, these properties serve for formalizing and analyzing models in other process modeling languages (such as in EPC (van der Aalst, 1999) and in general workflow (van Hee et al., 2008).

The mathematical semantics of Petri nets (and of WF-nets) is based on the dynamics of tokens that propagate through the net. While supporting formal analysis of process dynamics, Petri net token-based models have several disadvantages. First, they provide abstraction of transitions that can occur during the process. However, being abstract, the transitions in a net do not necessarily convey clearly the real world (dynamic) phenomena that occur in the domain in which the process operates. In other words, a transition does not necessarily reflect a change in the domain that has a clear meaning to stakeholders. In particular, no rules exist for mapping of the real world domain (part of an organization or a business) in which the process takes place into a WF-net beyond the general requirements of WF-nets. Hence, such models are not necessarily meaningful to stakeholders and, beyond that, processes represented by WF-nets might not even be feasible to execute in practice or might not be able to accomplish stakeholders' goals. Second, an important advantage of WF-nets is that they possess several structural or behavioral properties which can be useful in formal analysis. Structural properties relate to the structure of the net, independent of its specific marking and include, in particular, free choice and well-structuredness (van der Aalst, 1998). Behavioral properties are initial marking dependent and include, in particular, soundness, separability and serialisability (van der Aalst, 1998; van Hee, Sidorova & Voorhoeve, 2008; Salimifard & Wright, 2001). However,

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