Selected Issues on Workflow Representation, Analysis and Verification

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Abstract

Business organizations use workflows to achieve their business goals. A workflow performs a specific business function by transforming the information available at the input to a more directly useful form. It consists of tasks from one or more functional disciplines that are linked together by precedence constraints.

The recent upsurge of research interest in workflows has focused the spotlight on three basic issues: a) For business applications, what is the most convenient graphical representation of a set of related workflows? b) Given such a representation, how can we efficiently analyse the information perspectives, functional perspectives and organizational perspectives of a process? and c) How can we verify that the constituent workflows are syntactically correct and display the flow of information accurately?

One way to model the flow of information in a business process is by a Metagraph. When information analysis is the primary objective, Metagraphs appear preferable to other schemes such as Petri nets for representing workflows. In practice,

however, Metagraphs have not achieved wide popularity. Here we propose a modification of the original Metagraph formulation that eliminates some of the inconveniences that have hindered the applicability of this workflow modeling scheme. In answer to a), we propose a structure similar to an AND/OR graph called a Task Precedence Metagraph (TPMG). A TPMG displays tasks and information flow with equal emphasis, unlike a Petri Net which is primarily concerned with the proper sequencing of tasks. Our Task-Precedence Metagraphs (TPMGs) are visually clearer and more appealing than ordinary Metagraphs. TPMGs not only represent the task precedences in workflows, but also pictorially show the input and output data for the individual tasks. TPMGs can represent the temporal constraints of tasks and between tasks as well. We have demonstrated the efficacy of our model with an implementation in a real-world case of maintenance of elevators in an organisation.

Items, tasks and resources are the most important constituents of a business process. Analysis of these elements and their interactions is most critical for achieving the business goals. In answer to b), we propose an information analysis procedure, called InfAnalysis, which is graphical rather than algebraic. InfAnalysis makes use of an edge-marking scheme commonly employed in solving AND/OR graphs in AI. InfAnalysis has been extended to perform task analysis and to handle resource constraints as well.

A business process supplied for execution must be free of semantic and syntactic errors for smooth functioning during runtime and achievement of its ultimate objectives. In answer to c), we propose graph search algorithms that perform syntactic verification and information analysis on TPMGs. AO* is unsuitable owing to the presence of AND joins and directed cycles. Our algorithm TPMG_SYN not only arrests the common structural errors like deadlock and lack of synchronization, but also detects directed cycles and complex overlapping patterns.

There is no existing method for ensuring semantic correctness. We introduce the notion of operational correctness which proposes that as long as a business process behaves as it is expected to behave by the manager and produces the expected outputs, it is correct in the operational definition of the process. We have proposed TPMG_OPER, which is an adaptation of TPMG_SYN, to check the correct flow of information and verify that the given process is operationally correct.

A future area of research will involve the incorporation of temporal constraints in the TPMG model. We believe that the algorithms in this thesis can be readily extended to check the consistency, prediction and scheduling of a process with temporal constraints.