

Chapter 67

Predicting Temporal Exceptions in Concurrent Workflows

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ABSTRACT

Current Workflow Management Systems (WfMS) are capable of managing simultaneous workflows designed to support different business processes of an organization. These departmental workflows are considered to be interrelated since they are often executed concurrently and are required to share a limited number of resources. However, unexpected events from the business environment and lack of proper resources can cause delays in activities. Deadline violations caused by such delays are called temporal exceptions. Predicting temporal exceptions in concurrent workflows is a complex problem since any delay in a task can cause a ripple effect on the remaining tasks from the parent workflow as well as from the other interrelated workflows. In addition, different types of loops are often embedded in the workflows for representing iterative activities, and presence of such control flow patterns in workflows can further increase the difficulty in estimation of task completion time. In this chapter, the authors describe a critical path based approach for predicting temporal exceptions in concurrent workflows that are required to share limited resources. This approach allows predicting temporal exceptions in multiple attempts while workflows are being executed. The accuracy of the proposed prediction algorithm is analyzed based on a number of simulation scenarios. The result shows that the proposed algorithm is effective in predicting exceptions for instances where long duration tasks are scheduled (or executed) at the early phase of the workflow.

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INTRODUCTION

In a highly dynamic business environment, simultaneously executing departmental workflows form digital business ecosystems (Boley & Chang, 2007) which are designed to share limited resources. In this chapter we address the temporal exception prediction problems of a digital business ecosystem involving concurrent workflows.

A workflow specification defines how a business process functions within an organization (Son, Kim, & Kim, 2005). Based on these specifications, Workflow Management Systems (WfMS) allocate and dispatch work to users (Li & Yang, 2005). A workflow instance is an execution of a workflow specification. During the execution of a workflow instance, some events that are not defined in the workflow specification may occur. These events are typically considered as exceptions in workflow management systems.

In the area of programming languages, exceptions may interrupt or abort the execution of a program. Exceptions in WfMS are also similar to those of programming languages. Two types of exceptions (Casati, 1998) can be defined in WfMS; expected exceptions which are the results of predictable deviations from the normal behavior of a process and unexpected exceptions which are the outcomes of inconsistencies between the business process in the real world and its corresponding workflow description.

A workflow specification may consist of several workflows that execute concurrently and share the same pool of resources. In large organizations, a number of different workflows could be executed simultaneously. These concurrent workflows are often interdependent since they are required to share limited resources. For example, two concurrent workflows designed, respectively, for an inventory management process and a delivery process may share the same human resources (e.g. a group of technicians) who are responsible for managing a storage facility and a fleet of vehicles. Delays occur when only a limited

number of resources are available during a given interval. We denote deadline violations caused by such delays as temporal exceptions.

In workflow management systems, control-flow patterns are used to describe the order of tasks that make up a process and the relationship between them (Van der Aalst, Ter Hofstede, Kiepuszewski, & Barros, 2003). In this chapter, we focus on predicting temporal exceptions for workflows which include iteration patterns (loops). Iteration pattern refers to a repeated execution of one or more tasks within a workflow. Although iteration patterns are extensively used in workflow specifications, less attention has been devoted to understanding their implications for temporal exceptions. Specifically, rapid changes in the number of iterations can cause deadline violations as well as conflicts in resource usage.

Our approach can be divided into two phases: *design time* phase and *run time* phase. During the design time, temporal and resource constraints are calculated for each task within the workflow specifications. During the run time, an algorithm is used to predict potential deadline violations of workflow instances by taking into account constraints calculated at design time.

The remainder of this chapter is organized as follows. In the following section we give a brief introduction to resource and temporal constraints in a workflow. Then we describe the critical path based method for exception prediction. Next we illustrate an example of temporal exception prediction, and evaluate the proposed method based on a simulation experiment. We then review recent related work and finally summarize our ideas.

OVERVIEW

A workflow management system can be used to host several simultaneously executing workflows. Conflicts usually occur when tasks from instances of different workflows compete for limited resources (e.g. human resources, financial resources, etc).

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