Knowledge-Based Systems 35 (2012) 320–331

Contents lists available at SciVerse ScienceDirect

Knowledge-Based Systems

journal homepage: www.elsevier.com/locate/knosys

Mining event logs to support workflow resource allocation

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ARTICLE INFO

Article history:
Received 23 March 2010
Received in revised form 26 April 2012
Accepted 22 May 2012
Available online 28 May 2012

Keywords:
Workflow
Resource allocation
Data mining
Process mining
Association rules

ABSTRACT

Currently, workflow technology is widely used to facilitate the business process in enterprise information systems (EIS), and it has the potential to reduce design time, enhance product quality and decrease product cost. However, significant limitations still exist: as an important task in the context of workflow, many present resource allocation (also known as "staff assignment") operations are still performed manually, which are time-consuming. This paper presents a data mining approach to address the resource allocation problem (RAP) and improve the productivity of workflow resource management. Specifically, an Apriori-like algorithm is used to find the frequent patterns from the event log, and association rules are generated according to predefined resource allocation constraints. Subsequently, a correlation measure named lift is utilized to annotate the negatively correlated resource allocation rules for resource reservation. Finally, the rules are ranked using the confidence measures as resource allocation rules. Comparative experiments are performed using C4.5, SVM, ID3, Naïve Bayes and the presented approach, and the results show that the presented approach is effective in both accuracy and candidate resource recommendations.

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1. Introduction

Workflow is now an embedded technology in many enterprise information systems (EIS, e.g. PLM, ERP, CRM, SCM and B2B applications). Workflow resource allocation serves as an indispensable link between workflow activities and resources, and it directly determines the execution quality of the workflow activities [1–3].

Based on our investigation, most of the resource allocation tasks in present workflow management systems are usually performed using a role-based approach [2,4,5]. That is, to divide the workflow resources (actors) into different candidate groups based on their role and the organization properties. Once the workflow cases are originated, the workflow engine assigns the works to proper resource groups [4,6]. Such resource allocation is somewhat coarse-grained and may fail in some situations. For example, in the manufacturing enterprises, a manufacturing process sheet work might be predefined to be undertaken by the resources with the role "process planning designer". Actually, some of the processes planning works have to be further assigned to a smaller group of one or more qualified designers instead of all the process planning designers. Thus, the present resource allocation methods may make inappropriate staff assignments and the final quality of the products may suffer from it. Therefore, in some industries such as the manufacturing enterprises, most of run-time workflow resource allocation works are still performed manually by the administrators. The number of administrators is usually small, whereas the activities are of great abundance in some cases. That makes it a time-consuming work to allocate the workflow resources manually.

Fortunately enough, contemporary workflow applications usually record the business events in event logs. These logs typically contain information about events referring to a case, an activity, and an originator [7–10]. The case (also referred to as process instance) is a work that is being handled, e.g. a process planning sheet design, a compressor design, an NC programming, etc. As the atomic element of the case, an activity is an instance of a workflow task. An originator is a resource (usually a person) that executes the activity [6]. In this paper, a Process refers to a workflow template of the case, a Task represents a series of similar activities, and a Resource refers to a task performer.

This paper presents an Apriori-like algorithm [11,12] to find frequent patterns from the workflow logs, which are used to generate rules according to a "resource allocation rule constraint". All the negative correlated rules are annotated with a rule evaluation measure referred to as "correlation measures". Then, the selected rules are ranked in a descending sequence by their confidence, and the final rules are then recommended to workflow administrators at workflow run-time.

The major contributions of this paper are as follows: First, it designs a closed-loop workflow framework for a more intelligent and finer-grained resource management. Second, it proposes an

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http://dx.doi.org/10.1016/j.knosys.2012.05.010

association rule mining approach to find the logics between workflow resources and the activities, which would help decision-making in resource allocation.

The remainder of this paper is presented as follows: In Section 2, we design a closed-loop workflow architecture for optimizing resource allocation. Later on, we study the workflow event models and their relationships in Section 3, and then propose our mining approach in Section 4. In Section 5, we empirically compare some classification algorithms (C4.5, SVM, ID3, and Naïve Bayes) with our approach. In Section 6, we discuss some possible improvements. Finally, we discuss the related works in workflow resource allocation in Section 7, and conclude this paper in Section 8.

2. A closed-loop workflow framework for resource allocation

Our work is based on a National Defense Project named Agile Process Preparation System (APPS) for a large radar-manufacturing corporation [13] in Nanjing, Jiangsu, China. APPS is a process-aware information system, and it applies a workflow module to manage the works of CAX units (e.g. CAD, CAM, CAPP, etc.). This workflow module manages the resources (performers/actors) using a closed-loop approach. The framework of the approach is illustrated in Fig. 1.

The closed-loop workflow resource allocation approach mainly includes three steps:

Step 1: The execution history of the workflow activities is recorded in a transaction log referred to as workflow log.
Step 2: The system utilizes an Apriori-like association rule mining algorithm to extract the resource allocation knowledge from the workflow log.
Step 3: Once a new workflow activity is originated, the system automatically recommends the administrator with a default resource and other proper candidates according to the mined association rules. The workflow administrator may simply approve the default assignment or choose another resource in the candidate list for the work considering the reality.

3. From workflow log to resource allocation rules

Our goal is to distill resource allocation rules with high prediction accuracy out of the workflow event log. A workflow event typically includes three primary kinds of information: the workflow process information, the workflow task information and the resource information. The association rule involving these three

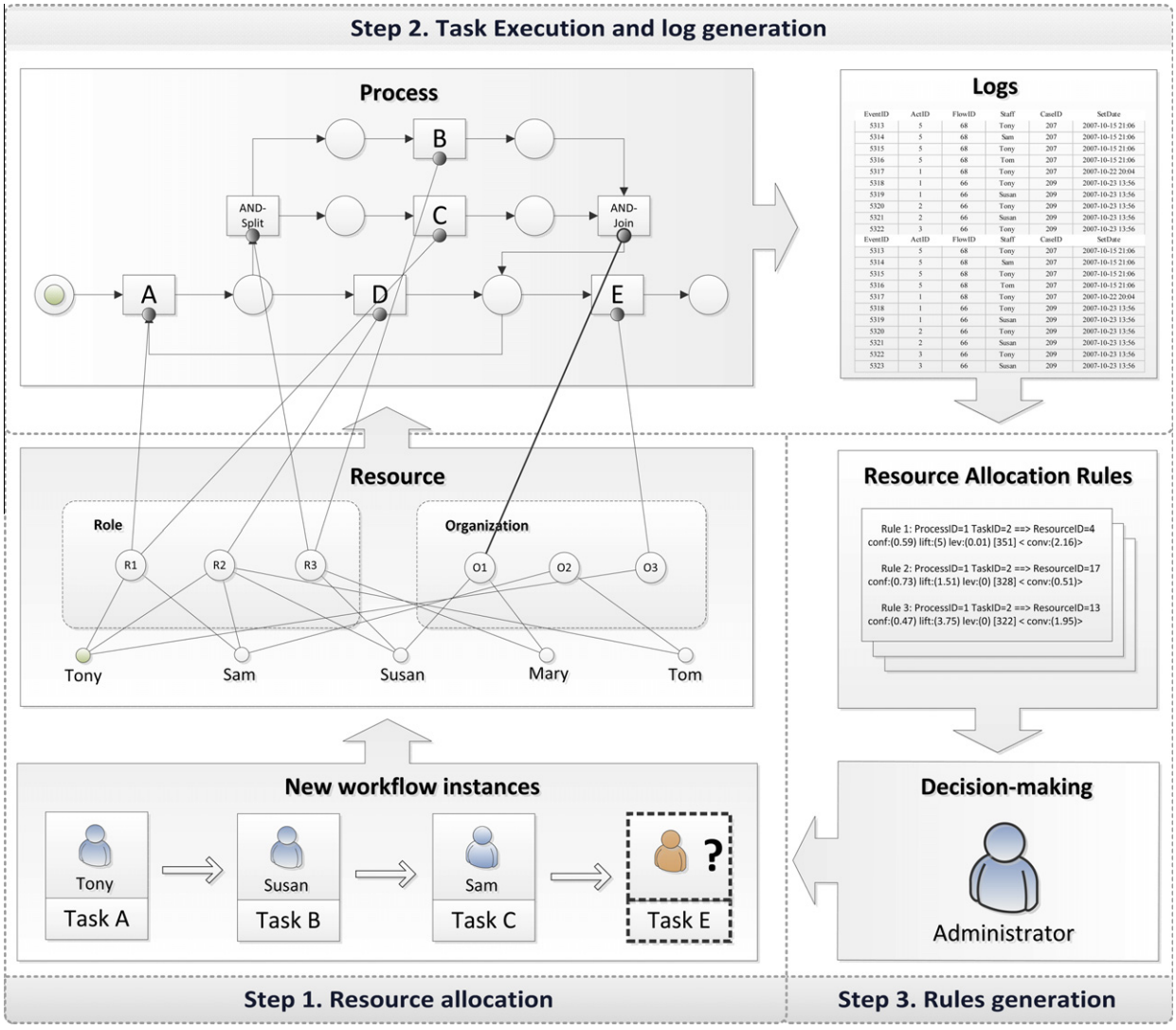

Fig. 1. Overview of the approach.

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