Chapter 43
The Analysis and Implementation of Universal Workflow with Partition Algorithm on Finite Field

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Abstract To guarantee the running of system without collapse when deal with the complex changes of personnel and departments and implement the compatibility of the workflow system within different kinds of enterprises under certain regulations, Workflow with Partition Algorithm on Finite Field denoted in this paper provides an efficient solution. According to the performance of the eventually practice, this strategy completely solve the problem of addressing the issues of personnel position and department architecture changes in an enterprise as well as the requirement of enforcing the compatibility of the workflow system when deploying on different enterprises and also reduce the cost of system designing and new user importing time.

Keywords Workflow · Partition on finite field · Organizational hierarchy

43.1 Introduction

The technology of workflow starts from researches on office automation in mid-1970s [1]. Many related works have been reported in the research of self-adaptive workflow system. Two strategies of selection-adaption, through defining some phases of the workflow system during the running period instead of the creation time have been denoted [2, 3]. An interaction framework in which Manual intervening when the running system encounters some certain situations has been

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provided [4]. An architecture named Tri GSflow intends to use object oriented technology to integrate the object oriented model, role model and rule model in the workflow system [5]. Then resolution strategy and method of flexible workflow were discussed in particular from theoretical and implemental sides [6]. Some improvements on the dynamic modeling method have been made [7]. And a method was proposed to construct workflow including loop dynamically.

However, there're still some challenges within the state of the art technology. For example, it's hard to guarantee the running of system without collapse when deal with the complex changes of personnel and departments. For another, current researches of the workflow are mainly limited within the scope of s single enterprise, that means it can only deal with the flow changes took place in one certain company.

The algorithm denotes in this paper can greatly relieve the problems described above and can thus significantly improves the performance of the current workflow system. It provides an effective solution for both situations mentioned above by firstly extracting valid keywords according to organization information the enterprise possessed, and then partitioning these keywords into finite fields which is necessary for dealing with the problems made by personnel change and department restructuring.

The description of finite field partition algorithm is presented in Sect. 43.2. Section 43.3 provides the implementation and Sect. 43.4 presents a workflow implementation of the algorithm. Then Sect. 43.5 presents some concluding remarks.

43.2 Finite Field Partition Algorithm

The elements of this algorithm are described below:

(1) Pattern of organization information constitution: That means the regulations followed by denominating of each department, institution and organization in an enterprise.

Definition 1 Denote the number of enterprises with universal workflow service as m, the information constitution pattern of every enterprise as P_i, $0 < i \leq m$. So the universal workflow information constitution pattern is as follow.

$$P = \{P_i | 0 < i \leq m\} \tag{43.1}$$

(2) Integrity Attribute of organization Information: the integrity designation of internal departments and organization according to constitution pattern.

Definition 2 Denote the integrity attribute of an enterprise as D_i, so the integrity attribute of universal workflow information is represented below.

$$D = \{D_i | 0 < i \leq m, P_i(D) \in P\} \tag{43.2}$$

(3) Hierarchy: The hierarchical relationship among the organizations according to compartmentalization from superior to inferior.

Definition 3 L_i describes hierarchy number of each enterprise which participates in workflow. The hierarchical relationship of universal workflow organization is as follow.

$$L = \{L_i | 0 < i \leq m\} \tag{43.3}$$

(4) Keyword: A group of distinguishing strings or string set for dividing information integrity attributes into separated string subset in reference to hierarchical relationship.

Definition 4 If the hierarchy number of an enterprise is L_i, the number of keyword subsets should be $L_i - 1$ since $L_i - 1$ subsets will separate the integrate information into L_i finite fields. K_i means all keywords of every enterprise for integrity attribute partition. The total of the number of keyword subsets in every hierarchy through the partition algorithm C equals $L_i - 1$.

$$K_i = \left\{ k | k \in K_i, \sum (C(k)) = L_i - 1 \right\} \tag{43.4}$$

The universal workflow keywords are as follow.

$$K = \{K_i | 0 < i \leq m\} \tag{43.5}$$

(5) Finite fields: describe the several fields from integrity attribute divided by keywords.

Definition 5 Assort the set of keyword from each enterprise ($L_i - 1$ in all) from high to low and match them with the integrity attribute of this enterprise. If a matched keyword (or an item of a keyword subset) is included, then partition this content as a finite field. Again, this attribute begins the next matching process with the next keyword after this partition, until all the keywords or keyword subsets in the set are processed. This procedure can be described as below:

```
1    counting variable I = 1
2    remaining properties after partition SD = D_i
3    the set of partitioned properties G = Φ
4    While I <= L_i-1 {
5        k = K_i (I)
6        IF SD ∩ k ≠ Φ
7        {
8            g = The content of SD partitioned by k
10           G = G ∪ g
11           SD = SD − G
12           I = I + 1
13       }
14    }
15    loop
```

According to the principle elements listed above, the hierarchy model is illustrated as follow (Shown in Table 43.1).

Following the parameter settings in the table above, the hierarchical partition of partition algorithm on finite field is demonstrated as follow. All of the internal departments in an enterprise are partitioned hierarchically. Hence, each node on the workflow can be defined by names of these departments and personnel (Fig. 43.1).

43.3 Implementation of Finite Field Partition Algorithm

43.3.1 Preparation of Basic Data for Workflow

(1) Draw keywords and number of ranks, which is also the maxim numbers of possible nodes in the workflow route, for partition from collection of sorted designations of all departments and organizations.

Table 43.1 An example of the principle elements

Elements	Examples
Constitution pattern of enterprise information	Including all complete designations from top to bottom
Integrity attributes of enterprise information	D: String 1 Keyword 1 String 2 Keyword 2 String 3 Keyword 3 String 4
Hierarchy	L: 4
Keyword	$K1$: {Keyword1},
	$K2$: {Keyword2},
	$K3$: {Keyword3}
Finite fields generated after partition	$G1$: {String1 Keyword1},
	$G2$: {String2 Keyword2},
	$G3$: {String3 Keyword3},
	$G4$: {String4}
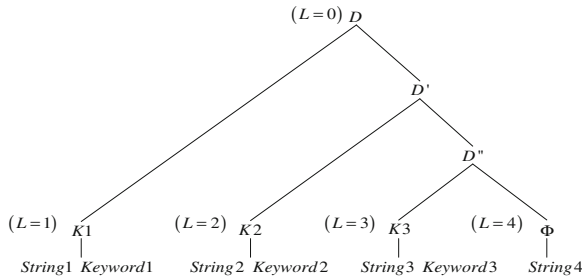
**Fig. 43.1** The hierarchical partition by partition algorithm on finite field

(2) Configure keywords and the number of ranks.
(3) Divide the integral department designations into distinct rank components according to the keywords.
(4) Input all position designations which may possibly appear on workflow approval routings.
(5) Set respective position designations for every employee in the staff table.

According to the steps listed above (shown in Fig. 43.2), the basic data can be prepared for establishing workflow approval routings as well as for flexibly implementing different workflow paths. Special implementation is shown in Fig. 43.3.

43.3.2 Path Establishing in Universal Workflow System for Basic Workflow

A stabilized, regulated and limited workflow should be established in any enterprise, whatever its scale. Or, workflow would lose its significance. Thus, the subsequence step is to build up the potential workflow route in the intern enterprise. This includes four steps listed below:

(1) Set work positions of every approval node on each workflow route.
(2) Set hierarchical mark number of those positions.
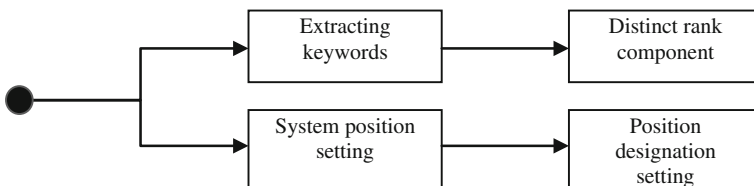
Fig. 43.2 The flow sheet of parallel processing of extracting keywords and system position setting
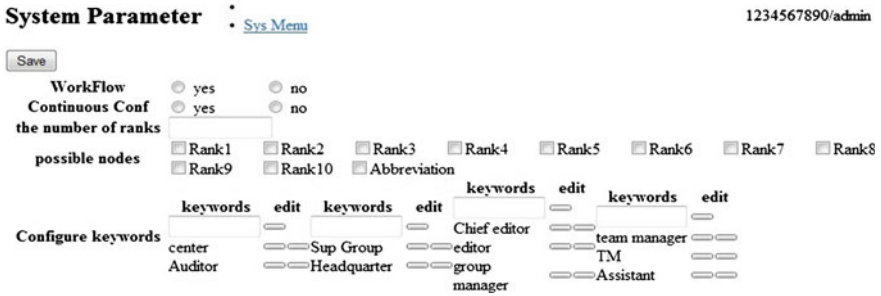
Fig. 43.3 Extraction of keywords for diving distinct rank components according to data analysis

(3) Iterate (1) and (2) until a workflow path is established.
(4) Iterate (1), (2) and (3) to create multiple paths for an enterprise.

Then, basic workflow routes can be established.

43.3.3 Workflow Setting for Special Field

In practical situation, besides the top-down approval structure in the regular enterprises, some special requirements are needed in certain ones. For instance, some enterprises require specialized quality control departments to participant in workflow approval. Otherwise, some need supervision departments activate throughout the process. Moreover, some allow employees in some certain departments that can join the procedure of approval, etc. Denote these spetial departments as special field and with those possible situations under consideration, we integrate those requirements in the universal workflow. The main steps of integration are listed below (shown in Fig. 43.4):

(1) When dealing with the scenario of department, such as quality control departments, special function departments and supervise department need to participate into the procedure of approval, we load the data of designations of those departments into the personnel position table of workflow system databases when setting the basic data. These special departments are named as special field.
(2) Set employees in relevant special departments. Normally, there are many in one.
(3) By analogy of work position, map those special departments to the nodes in the workflow.
(4) According to the different ways employees in those special departments participate into the workflow, divide the special field into collateral filed and exclusive field. All members in compatible field should join the tasks of the workflow node, the moment for participating in workflow. One and only one of those members in exclusive field should join the tasks of the workflow node.
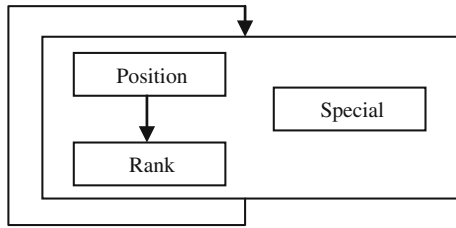
Fig. 43.4 Flow sheet of route setting of basic workflow and workflow containing special field

(5) According to the special filed nodes which participate into the action of workflow, Special field can also be divided into two different types: partial field and global field. Partial field has its unique working sequence, which means workflow members in partial field will join workflow tasks in special setting time while following the workflow order. Members of Global field in this field can join workflow tasks any time. In another word, no specific sequence is existent. In universal department, the approval timing of a member follows the time-order, like other members. The specific implementation is shown in Fig. 43.5.]

43.4 Workflow Implementation

After completing three main steps illustrated above, the basic workflow route should be established. Then, the final implementation is available. The critical point in this procedure is to allocate preset roles to single employee. Otherwise, department designations which partitioned by low, can bring us convenience

Fig. 43.5 Setting approval nodes of every rank on the route of workflow containing special field

Workflow Route GEQC

OK BACK

Role Route

Role	Authorizer Dept	Authorizer	Authorizer Role
Assistant of Team Manager	ATM of Center for Global Environmental Research	⬭	ATM
Team Manager	TM of Center for Global Environmental Research	⬭	TM
Assistant of Group Manager		⬭	
Group Manage		⬭	
Quality control Dept	Manager of Quality control Group	⬭	QC
President;Officer;Sup Director	Vice President	⬭	Vice President
Human Resources Group			

Fig. 43.6 Ascertaining an individual route of workflow

to easily confirm each roles on the approval route instead of searching rank relationships among complex staff tables. The main steps are listed below:

(1) Select a workflow route or automatically generate one depending on the different approval content.
(2) Gain all the finite fields of the applicant's department.
(3) Determine the next node which should be approved, and gain the position and the position rank number of the approval manager.
(4) Gain the desired finite fields of confirmer and its department finite fields by matching designations gained in step (2) with rank number.
(5) In this department, determine a approval manager in the members who own the position mentioned in step (3).
(6) Submit the approval request to the selected approval manager.
(7) Let the approval manager be the requirement submitter, and iterate steps from (2) to (6) until the whole workflow route is established.

The special implementation can be seen in Fig. 43.6. After selecting a certain route of workflow in the basis of user information, ascertain an individual route of workflow according to the relevant information of position and role of system settings.

43.5 Conclusion

Since it works on the enterprise information basis, the special-field workflow system based on partition algorithm on finite field can perfectly meet the requirements of organization structure changing and personnel switching. Moreover, because organization information is internal resources of an enterprise, there is no need to do a lot of system-oriented design. Therefore, it can significantly reduce the cost of system designing and new user importing time. Currently, almost all the workflow systems adopt the security mechanism based on the Task-

Role access control. However, with the system become more and more complex, other approaches are necessary to guarantee the security of the system. For example, the mixture pattern of Task-Role access control and self-adaptive mechanism can improve the system security in distributed environment and this will be our future work.

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