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Toward Activity Mapping for Artifact-Centric Business Process

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Abstract

The existing method of task mapping between process models is mostly based on the similarity of labels to get the similarity between tasks, which is affected by a single factor and easy to cause errors. This paper proposes a task mapping method for Artifact-Centric business process analyzes the data operation in business process execution. At first we add the description of data operation to EZ-Flow model. Secondly select the similar artifact attributes of the two business artifact by whole artifacts similarity calculation and based them to calculate two tasks' similarity by label similarity, artifact operation similarity and context similarity calculations. Finally, the task mapping comes from the optimal selection of tasks' similarities. Experimental results verify the effectiveness of the method, and show that the method reflects the data operation characteristics of business process model, as artifact task mapping of the process model provides a feasible method.

Keywords: *Task Mapping; Artifact-Centric, BPM*

1. Introduction

With the arrival of service economy era, enterprise business cross-border integration has led the trend, the amount increases as the core assets of the enterprise business process complexity increases, adding difficulty to the management of enterprise business process. In order to manage and make full use of enterprise business process, scholars at home and abroad begin to focus on process searching, process merging and process clustering. Among these, process comparison is the foundation, whose first step is to establish the mapping relationship among the elements in the process model, which is to find the corresponding tasks and resources in the process A from the process B.

Considering the complexity of business process graph model itself in routing structure, execution semantics, resource allocation and so on, it is not easy to make a comparison, especially in data centric business process model. However, relevant research is rare. In most of the related research in the process comparison, the mapping of the process elements (*i.e.*, task, resource, *etc*) is simplified. One of the most commonly used method is to realize the mapping relationship between elements by comparing the elements of the tag, while the label of the elements is generally a string, so we can judge the existence of mapping relationship between two labels by whether the two strings are similar or identical. There are many ways, such as String Edit Distance, semantic similarity search, the longest common sub sequence, *etc* to compare the strings, they are just the comparison

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of the tags whatever the method kind. But in the actual scene, different strings may also represent the same element. In this case, it is not enough to simply compare the tags of the elements, but it is also needed to determine the mapping relationship of elements in the process according to the execution semantics, routing structure, data structure, and so on. Therefore, the method of element mapping in the process needs to be redefined.

For example, in Figure 1, two tasks respectively belong to two different business processes, task1 identifies the name as "submit", task2 names "application", the two words are different in meaning, but in fact, they do the same thing - submit the application form to the relevant departments for verification, that is to say, the relevant data application and submit are the same, so tasks 2 and 1 can actually be judged to be highly similar.

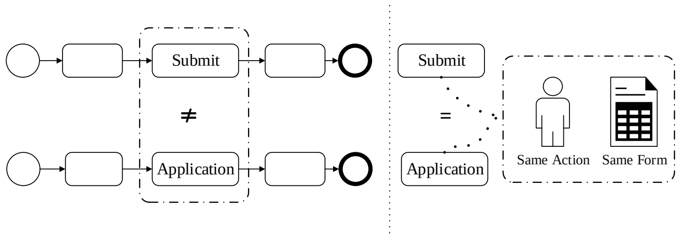

Figure 1. Task Similarity Calculation based on Label Similarity

In this paper, based on the deficiency of the task mapping method above, we study the data related characteristics of the artifact-centric business process [1], and propose a method of task mapping for artifact-centric business process, which breaks the bottleneck of traditional workflow which compares task labels only, to bring new minds to study the process mapping. The lifecycle model of the EZ-Flow [2] is represented by a state machine, and the element is active and state, and can be described by artifact. That's why we choose EZ-Flow model.

The major contributions of this paper include the following points:

- By combining with the actual business process of Hangzhou housing information Co., Ltd., this paper summarizes the types of the operation of the data in the artifact-centric business process and extends the EZ-Flow model to support the data operation.
- Add the artifact similarity to the influence conditions of business process task similarity which depending on the data properties of artifact-centric business process, and propose an algorithm to calculate the artifact similarity.
- Add the operation of artifact attributes to the influence conditions of business process task similarity depending on the relationship between the lifecycle of artifacts and the business process tasks, and propose the algorithm to calculate the artifact attributes operation similarity.
- Build the context of tasks by the input artifacts and the output artifacts of the task depending on the data properties of artifact-centric business process and the relationship between the lifecycle and task, and propose an algorithm to calculate the similarity of contexts of two tasks.
- Finally we get the artifact-centric business process tasks mapping method by synthesizing the above several methods, and we take the experimental to verify and analyze the method.

The major content of this paper includes the following points: Section 1 gives a general introduction of the mapping method of tasks in this paper. Section 2 gives the relevant theory. Section 3 presents the mapping method of EZ-Flow process, and designs the corresponding algorithm. Section 4 carries out the experimental evaluation and comparison based on the real business process data set. Section 5 describes the relative work. Section 6 describes the summary of the full text of the research work, and looks forward to the future work.

2. Preliminaries

EZ-flow is an effective way for Artifact business process model's building and analysis. EZ-Flow combines the business data and the business process, and the data changes in business process can be seen as the main line of process design. An EZ-Flow model consists mainly of several kinds elements like Artifact, task and repository. Artifact is a business entity which is self-describing and identifiable. Tasks could operate the Artifacts , repository is used to store Artifacts' states among its lifecycle. Task will read, write or alter the values of Artifacts according to such business rules. Considering actual application scenarios, we briefly describe EZ-Flow as follows.

Definition: an EZ-Flow model is a tuple $M = (C, R, \Sigma)$, in which C is the Core Artifact, R is a set of finite states, which contains all Artifact states generated in an EZ-Flow instance. Σ is a set of tasks.

Example: Figure 2 shows an EZ-Flow process model. In this case, affortble housing application is the core Artifact, so that the business process works around it.

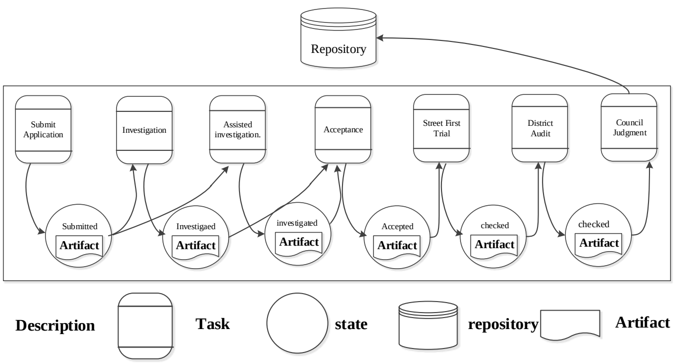

Figure 2. Example of EZ-Flow Model

In order to describe the artifact's operation in its lifecycle, we define the operation type and add it to the Artifact type's definition.

Definition: an artifact is a tuple $A = (n, \rho)$, in which n is the set of Artifact attributes, ρ denotes the operation of an Artifact attribute, $\rho \in \{P, L, M, A, N\}$ .The means of P, L, M, A, N as follow:

Table 1. Artifact Operation Types

Type	Name	Description
P	Persist	Put artifact attribute and its value into database. The value comes from user's input
L	Load	Load from database
M	Modify	Load from database and rewrite to database
A	Automatic	Persist storage but the value comes from system
N	Null	Do nothing

Definition: A *task* is a tuple $t = (m, p, I, O)$ in which *m* is the name of the task, *p* is the type of task, *I* and *O* are respectively short for input and output.

Definition: A *repository* is a tuple $r = (\mu, \tau, c)$. μ is the name of the repository, τ is the type of the repository, a repository can be an inner one or an outer one. *c* is an Artifact which storing in the repository. In fig.2 there is only one outer repository.

3. Method Overview

In this paper, we study the task mapping in EZ-Flow process, and the method framework is shown in Figure 3, including the following steps: (1) the similarity of task identification; (2) the task of the Artifact data operation similarity computing; (3) the similarity of task context; (4) task similarity aggregation, and ultimately to the task mapping.

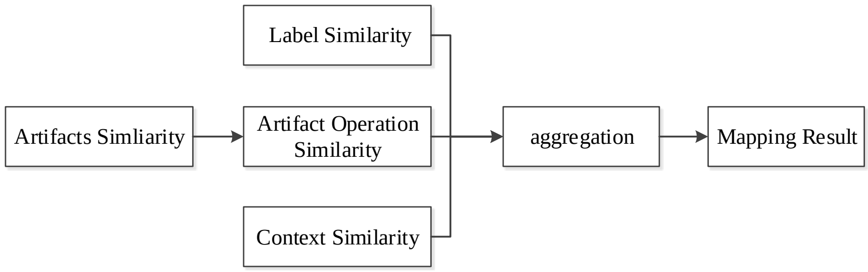

Figure 3. Method Overview

A. Lable Similarity

In business process management, each task or activity in enterprise organization does not only belong to a particular business process, but for different business requirements, these tasks will likely be used in different process with other tasks, and help processes dealing with specific business purpose. Therefore, one task can occur in many different process models. In EZ-Flow modeling, every element's name responses to such a label by which people could identify a task, so that people also could identify whether two tasks are the same by label in way. Generally label is presented as a string, so that we can use all kinds of string similarity calculation method to get two task labels' similarity. Now a days there is a lot of methods to get string similarity, and in this paper, we use semantic similarity to calculate the similarity of task identification. In this paper, we use semantic similarity to calculate the label similarity and the specific process is no longer here.

B. Artifact Operation Similarity

Artifact is the core data in the business process, it's recorded as a dynamic entity of a full lifecycle. The artifact includes the core business information in the business process execution and marks the progress and status of the process. Artifact states in each stage of its lifecycle is actually the result generated by the artifact passing a task, so that artifact is one of the key factors for the process task mapping.

Definition: $A_i = \{a_1, a_2, \ldots, a_n\}$ and $B_j = \{b_1, b_2, \ldots, b_m\}$ are respectively denote two artifact attributes set in two different business process p1 and p2. Sim(Ai, Bi), called artifact similarity, denote the similarity of Ai and Bi. we can get artifact collection similarity by equation (1):

$$sim(A_i, B_j) = \frac{\sum_{i}^{n} \sum_{j}^{m} (sim(a_i, b_j) > loweast\_sim)}{commonA.length} \quad (1)$$

In equation (1), commonA.length is the number of Artifact attribute similar pairs that in one attribute pairs, one Artifact attribute belongs to p1 and the other belongs to p2. We give a value called lowest_sim which is the lowest value which helps to identify whether Ai and Bi can be seen as similar likely.

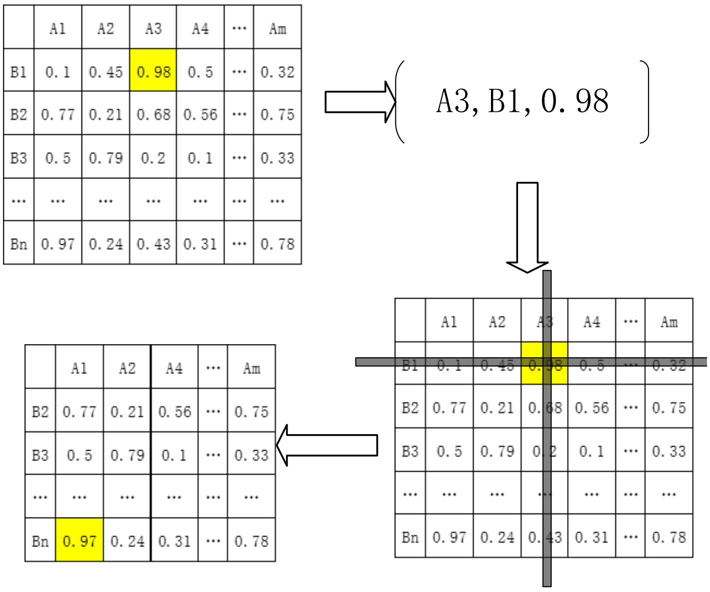

Figure 4. Selection of the Optimal Similarities

First a temporary similarity matrix of two artifact collection could be got by pairwise comparison using the segmentation and semantic analysis and calculation, and then using a greedy algorithm, shown as Figure 4, each step pick a maximum value from the temporary matrix results until the value smaller than lowest_sim which is 0.8 decided by experiments, and add the maximum value and two related tasks to a set of tuple c=(Ai , Bj , Sim(Ai, Bj)) which is called CommonA. After that, delete the related row and column in the temporary matrix. Finally we can get the artifact collection similarity

In fact Business process execution is each artifact attribute complete the assignment operation according to the lifecycle. In other words, the artifact is foundation of the execution of the tasks, so that two tasks could be seen as same or similar only if their similar artifacts have same operations. In a word, Artifact operation similarity is very important for task mapping between two different business processes. We already get the set commonA and we can use it to get the Artifact operation similarity between two tasks. Step1,we get the similarity of artifact attributes occurs in two tasks, and step2 we get the operation similarity of the artifact attributes got in step1. The method shows in formula2.

$Input : A->t_1, A->t_2, CommonA$

$Output : opt\_sim$

$Begin$

(1) $initial : common = 0; common\_num = 0$

(2) $foreach\ a_i\ in\ A->t_1$

(3) $foreach\ a_j\ in\ A->t_2$

(4) $if\ (a_i, a_j)\ in\ CommonA$

(5) $common += \frac{sim(a_i, a_j) + isEqual(a_i.\rho, a_j.\rho)}{2}$ (2)

(6) $common\_num++$

(7) $endif$

(8) $end\ foreach$

(9) $end\ foreach$

(10) $opt\_sim = \frac{common}{common\_num} \times \frac{A->t_1 \cap A->t_2}{A->t_1 \cup A->t_2}$

(11) $return\ opt\_sim$

End

The row 1-9 is to calculate the similarity of each pair of artifact attributes and get the average value as the result. Row 10 is to calculate the similarity of artifact instance operated by tasks. $\left|A->t_1 \cap A->t_2\right|$ is the intersection of the artifact attributes operated by the two tasks, and $\left|A->t_1 \cup A->t_2\right|$ is the union.

C. Context Similarity

As mentioned above, a number of tasks according to the combination of different ways can generate different business processes, so in a business process, a task doesn't appear in isolation, it is a part of the structure of business processes, sequence relationship exist in tasks which are independent and interrelated. So the context similarity also affects the results of tasks mapping between business processes in a certain extent. By the analysis of EZ-Flow process model, we give the context environment the following definition:

Definition: The model of a business process in a EZ-Flow model, for any one task, using the input artifact attributes set and output artifact attribute set to represent the task's context.

We define the context definition as that because the input artifact attributes are always affected by the previous task, and the output artifact attributes always could affect the next task, so that to a certain extent, they could show the state of current task which in the middle of previous task and the next task. And the definition also present the thinking of data-centric or artifact-centric.

By using artifact attribute similarity algorithm, we can respectively get the input artifact similarity in_sim and the output artifact similarity out_sim between two tasks. The context similarity is mean of the two value, shown as equation 3.

$$Context\_sim = (in\_sim + out\_sim)/2 \tag{3}$$

D. Task Similarity and Mapping

Task similarity consists of label similarity, artifact operation similarity and context similarity. We use sim(t1, t2) to present task similarity, label_ sim(t1, t2) present the label similarity, opt_sim(t1, t2) present the artifact operation similarity and sim(t1, t2) present the context similarity, then we get the equation 4:

$$\begin{aligned} sim(t_1,t_2) &= \omega_1 \times label\_sim(t_1,t_2) \\ &+ \omega_2 \times opt\_sim(t_1,t_2) \\ &+ \omega_3 \times Context\_sim(t_1,t_2) \end{aligned} \tag{4}$$

ω_1, ω_2, ω_3 are weight for label similarity, artifact operation similarity and context similarity respectively, each of them is among 0 and 1, and in this paper, we make them be 1/3.

Finally we can get task mapping by the collection of task similarity. For two tasks, if their similarity larger than such a minimum value which we set 0.5, they can be a pair of mapping. If one task match more than one task in another process, we pick the largest similar tasks pair as a mapping.

4. Experiments

This section will verify effectiveness and efficiency of the proposed method through the accuracy and performance The experimental data comes from Hangzhou housing information Co., Ltd.

Experiments are carried out in a unified environment: Intel® Core™ i5-3470 CPU@3.2GHz 3.20GHz. The experimental procedure using Java language, running on 64 bit Windows 7 system, JDK version is 1.8.0.

E. Effect analysis

Firstly, we need to verify the accuracy of the method by using artificial data in a priori condition. The artificial data is processed and to simplified the housing to provide business process. These experimental procedures exist that can be used as a mapping of several tasks. The following is the accuracy to validate this method comparing with simple label semantic similarity method.

We can obtain the following results shown as Figure 5 just by the label similarities.

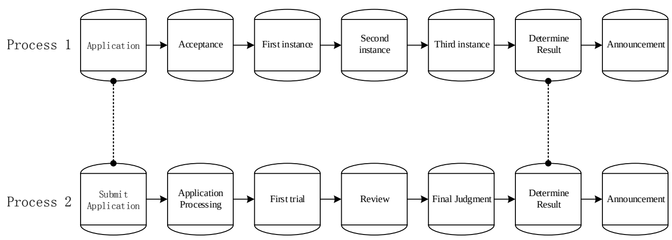

Figure 5. Mapping Based on Label Similarity

In this experimental group, the (application, submit application) and the correct mapping to confirm the results to confirm the results on the two tasks, their similarity were 0.83 and 1.00. A process in the first instance, the second trial, the third instance three tasks and processes2 "First Trial", "Review" and "Final Judgment" three tasks in bright the same semantic similarity 0.68 so that we could not get mappings, the rest of two because similarity is too low can not think is that the mapping relationship.

And we can obtain the following results shown as Figure 6 and Table 2 by the method proposed in this paper.

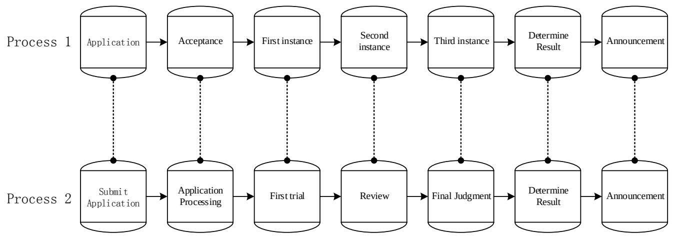

Figure 6. Mapping Based on our Method

Table 2. Mapping of Artificial Processes

Process1	Process2	Similarity
Determine Result	Determine Result	0.891667
Application	Submit Application	0.863969
Third Instance	Final Judgment	0.757835
First Instance	First Trial	0.753848
Second Instance	Review	0.724129
Acceptance	Application Processing	0.723927
Announcement	Publicity	0.71339

The experimental results are consistent with the expected results, and the correct mapping relation is obtained. And the probability of the same similarity value is also reduced greatly because the data, context and other constraints are added in the algorithm.

In order to determine the weights of the algorithm, the artificial test data may be made more ideal, so we use real data afforded by Hangzhou housing information Co., Ltd. business process repository to carry on the experiment, and by Hangzhou affordable housing and Urumqi, affordable housing in the application process of the real business data for mapping the simple analysis.

We can obtain the following results shown as table.3 just by the label similarities.

Table 3. The Mapping by Label-Similariy

Process1	Process2	Similarity
Final Judgment	Council Final Judgment	0.832050294
First trial	Street First Trial	0.832050294
Review	Comprehensive Review	0.636284763
Council Publicity	District Audit	0.404226042
Acceptance	Investigation	0.404226042
Public modification	Submit Application	0.391342226

From Table 3 we can see that similarity value above 0.5 have (Final Judgment, the Council Final Judgment), (First Trial, Street First Trial), (Review, Comprehensive Review) so that we find three pairs of mappings.

And shown as Table 4 we can obtain the result that it has 5 pairs of similarities which are above 0.5, and the 5 pairs of tasks can be considered to be one-one corresponding by the relevant workers' verify. Compared with Table 3, the similarity of (Acceptance, Submit Application) decreasing greatly as well as it has the impact of artifacts deeply. One the other hand, the similarity of (Final Judgment, the Council Final Judgment) has decreased in constract, which indicates that our method has a certain correction effect on the calculation error caused by the high task label similarity.

Table 4. The Mapping by our Method

Process1	Process2	Similarity
Final Judgment	Council Final Judgment	0.743741
Review	Comprehensive Review	0.717175
Council Publicity	District Audit	0.649897
Acceptance	Submit Application	0.636462
First trial	Street First Trial	0.630746
Public modification	Investigation	0.415658

Through the analysis, we can see that the task mapping method based on artifact-centric has a certain effect upgrade compared to the existing mapping method.

F. Performance Analysis

In order to further verify the availability of the proposed method, we have analyzed the parameters in the algorithm by experiments.

The number of tasks in the business process determines the length of the sequence of operations. In order to research the influence of the tasks' number on the performance of the algorithm, in the experiment, we maintain the artifact attributes number in a stable size, while the number of tasks decreased from 5 to 40, the step length is 5, and the result is shown by Figure 7.

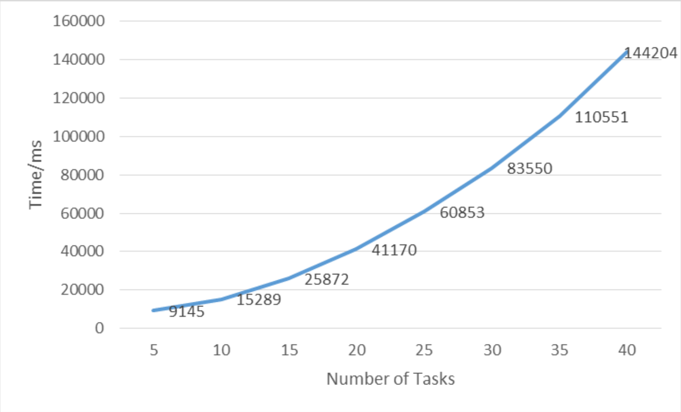

Figure 7. Effect of Tasks Number on the Performance

We can see that the execution time increases with a quadric function of the number of tasks while the artifacts number is fixed, so that the number of tasks has the great influence on the mapping method performance.

The number of artifact attributes in the business process determines the amount of the operation. In order to obtain the influence of the number of artifact attributes on the method performance, in the experiment, the number of tasks remains unchanged, and the number of artifact attributes is set from 20 to 160, and the step length is 20. The result shown as fig.8 said that, the execution time increases with a gentle linear function of the number of artifact attribute pairs number. The result indicates that the number of artifact attributes does not have great influence on the mapping method performance.

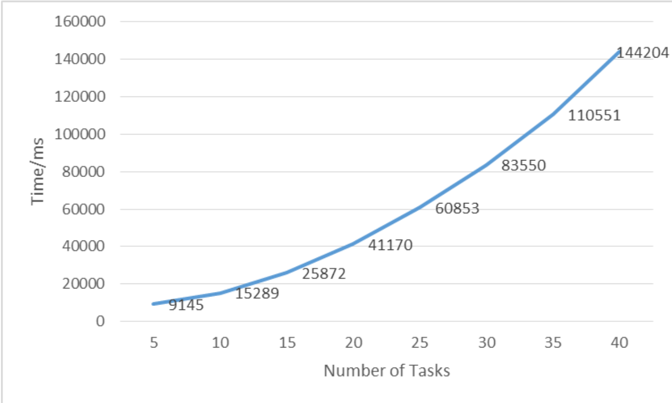

Figure 8. Effect of Artfact Attributes Number on the Performance

5. Related Work

The concept of artifact-centric [1] was proposed by Nigam and Caswell *et. al.*, IBM, in 2003 and artifact was defined as an identifiable and self-described business entity. Related formal definitions were given in [3], and this paper also carried out the static analysis of Artifact-Centric business process modeling. Cohn D *et. al.*, [4] describe artifact-centric process model including information model and lifecycle, information model presents the data structure of artifact which looks like database and lifecycle is described as the operation steps on artifact for the business goal. Richard Hull [5] presents a structured framework for a class of data-centric business process models, which are based on “business artifacts”, Which in paper provides a brief survey of research results on artifact-centric business process, and identifies a broad array of remaining research challenges.

There is only a few research on business process elements mapping, especially for artifact-centric business process. In most of the related researches on business process comparison, the process elements (*i.e.*, tasks, resources, *etc*) mapping are always simplified. Jochen *et al*., [6] divided business process into different fragments by SESE (Single-Entry-Single-Exit) [7] and made them into mapping, but they did not proposed such a mapping method for the gateway elements to connect SESE fragments. Dijkman *et al*., [8] abstracted different business process model into classical point-line graphics, cause elements information lost and couldn’t ensure the reliability of the result. A business process similarity calculation method [9] models the process by BPMN, it only remains the task elements after abstracting and give task name the text annotation, through the calculation of tasks and structure similarities to get the matching degree between the two business processes. An elements mapping method [10] based on petri-net makes up for the deficiency of the element mapping method based on graph matching, using petri-net as the modelling method, it presents the Hungarian algorithm based query method, where firstly define the context similarity for a pair of place nodes that are from different process models by taking into account both the common paths and common transitions, then transform the elements mapping to classical assignment problem that can be solved by Hungarian algorithm efficiently. Process version control application also needs to compare the processes. Weber *et. al.*, [11] have classified the pattern of change in the process, but some of them still need artificial judgment, such as the non mission node elements, the change of the related tasks and so on. M La Rosa *et. al.*, [12] used the matching score which they employ is related to the notion of graph edit distance. They used this matching score as it performed well in several empirical studies to complete mapping between two activities. Pedersen *et al.*, [13] proposed a linguistic similarity measure, based on the Wordnet::Similarity package.

6. Conclusion

In order to solve the problem that there is no effective method on task mapping between artifact-centric business processes, we proposed a method based on EZ-Flow model. The method focuses on the data operation during the process execution, and we also add the data operation to the process model definition. The method not only hold the existed label similarity method, but also use the artifact operation of task and build the task context by input and output artifact

Further research should be taken in the following directions: (1) The mapping method proposed in this paper has some weight parameters, how to adjust the parameters to achieve the best mapping result is the most important issue in the future. (2) In a number of potential mapping combinations, the impact on the application scenarios of the actual business process management, which is the best mapping combination and other issues also need to be further studied in the future. (3)How to apply my mapping method to the particular scenes, such as business process differences calculation and similarity calculation, as well as how to improve the efficiency and accuracy of the method on these scenes are important works in the further study.

Acknowledgment

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References

[1] A. Nigam and N. S Caswell, “Business artifacts: An approach to operational specifi-cation”, Ibm Systems Journal, vol. 42, no. 3, **(2003)**, pp. 428-445.

[2] W. Xu, J. Su, Z. Yan, J. Yang and L. Zhang, “An Artifact-Centric Approach to Dynamic Modification of Workflow Execution”, On the Move to Meaningful Internet Systems: OTM, Springer Berlin Heidelberg, **(2011)**.

[3] C. E. Gerede, K. Bhattacharya and J. Su, “Static analysis of business artifact-centric operational models”, IEEE International Conference on Service-Oriented Computing and Applications (SOCA 2007), Newport Beach, CA, United States, **(2007)**, pp. 133-140.

[4] D. Cohn and R. Hull, “Business artifacts: A data-centric approach to modeling business operations and processes”, Bulletin of the IEEE Computer Society Technical Committee on Data Engineering, vol. 32, no. 3, **(2009)**, pp. 3-9.

[5] R. Hull, “Artifact-centric business process models: Brief survey of research results and challenges”, On the Move to Meaningful Internet Systems: OTM 2008, **(2008)**, pp. 1152-1163.

[6] J. M. Küster, C. Gerth, A. Förster and G. Engels, “Detecting and resolving process model differences in the absence of a changelog”, In Proc. of the 6th Int’l Conf. on Business Process Management, **(2008)**, pp. 244-260.

[7] J. Vanhatalo, H. Völzer and F. Leymann, “Faster and more focused control-flow analysis for business process models through sese decomposition”, In Proc. of ICSOC, **(2007)**, pp. 43-55.

[8] R Dijkman, D. Marlon and G. B. Luciano, “Graph Matching Algorithms for Business Process Model Similarity Search”, In Proc. Of the 7th Int’l Conf. on Business Process Management, **(2009)**, pp. 48-63.

[9] R. M. Dijkman, M. Dumas and L. García-Bañuelos, “Graph Matching Algorithms for Business Process Model Similarity Search”, **(2009)**, pp. 48-63.

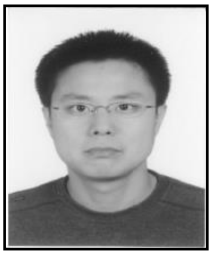
[10] B. Cao, J. Wang and J. Fan, “Mapping Elements with the Hungarian Algorithm: An Efficient Method for Querying Business Process Models”, Web Services (ICWS), 2015 IEEE International Conference on. IEEE, **(2015)**, pp. 129-136.

[11] B. Weber, M. Reichert and S. Rinderle-Ma, “Change patterns and change support features–enhancing flexibility in process-aware information systems”, Data & knowledge engineering, vol. 66, no. 3, **(2008)**, pp. 438-466.

[12] M. La Rosa, M. Dumas and R. Uba, “Business Process Model Merging: An Approach to Business Process Consolidation”, Acm Transactions on Software Engineering & Methodology, vol. 22, no. 2, **(2012)**, pp. 3-13.

[13] T. Pedersen, S. Patwardhan and J. Michelizzi, “WordNet:: Similarity -- Measuring the Relatedness of Concepts”, National Conference on Artifical Intelligence, **(2004)**, pp. 1024-1025.

Authors



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