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Multifaceted Service Identification: Process, Requirement and Data

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Abstract. Service Identification is one of the most important phases in service-oriented development methodologies. Although several service identification methods tried to identify services automatically or semi-automatically, various aspects of business domain are not taken into account simultaneously. To overcome this issue, three strategies from three different aspects of business domain are combined for semi-automated identification of services in this article. At first, the tasks interconnections within the business processes are considered. Then, based on the common supporting requirements, another tasks dependency has been determined and finally, regarding the significant impact of data in business domain, the last tasks relations are specified. To combine these three strategies, task-task matrices are used as a common language and eventually services are identified by clustering the final task-task matrix.

Keywords: Service Identification, Business Process Model, Goals Model, Task-Task Matrix, Clustering.

1. Introduction

Service Identification is the process of finding and extracting services from business requirements [1]. In recent decade several methods are presented to identify services. Although these methods use different strategies, approaches and techniques [2], the task of identifying services from various inputs has not yet been sufficiently solved [3]. Moreover, the lack of a systematic method that examines business from multiple perspectives and considers service quality attributes, causes service identification still remain a challenge to organizations [4]. Several researches have suggested service-modeling approaches that can identify and specify service components [5,6,7]. However, since they only provide descriptive guidelines to define services, it is less obvious and objective to apply those approaches, and even then, it is more dependent on experience and intuition [8].

Business process-driven strategy is a well-known strategy for service identification. A business process is defined as a set of tasks performed in coordination to achieve business objectives [9]. Identification of services by decomposing the business processes, which provides cohesive right-grained functionalities, is proposed by some methods [10]. In these methods services are identified based on the connections between tasks within the business processes. A major benefit of this approach is that the identified services satisfy functional needs [11]. Also the simplicity of understanding and modeling the business processes and workflows persuades researchers to use this strategy. However, a large gap between business process and applications as well as non-reusable services may result if services are only modeled according to business process specifications and without taking requirements and data into account. Furthermore, business process-driven approaches mainly focus on structural relations between tasks and ignore the conceptual ones. Actually, tasks can be related through their supporting requirements. Based on this idea several methods have been proposed to identify services using goals and requirements [12,13,14]. These methods are introduced based on the accepted principle that the functionality of a system should be traceable to business goals and requirements [15], because business goals can be lost in technical architecture of systems if systems are developed without considering the relationship between the requirements and the identified services [14]. In other words, to identify appropriate services, business requirements should be analyzed to meet the business objectives, agility and reusability [16,13]. The great benefit of goal-driven approaches is that their resulting services are reusable and have guaranteed fit with the organizations goals [13], but the lack of consideration of tasks inter-relations within workflows may result in a large number of calls between resulted services. In addition, goal-driven approaches do not consider level of goals and their relations.

Data indicates the main stable domain abstraction of an enterprise [17]. Recently data-awareness is taken into consideration in several domains of business process management and service computing. Even more researchers believe that process and data are two sides of the same coin [18]. In fact, since each task in a business process may have access to one or several business objects, data in terms of object or entity plays a major role in service identification. In addition, data-aware service Identification can resolve several challenges of process-oriented approaches [19].

In summary it can be said that to identify appropriate services, structural and semantic relations between service functions, which are equivalent to the tasks of process, should be taken into account. To consider the structural relations, the tasks inter-connection which shows the tasks dependencies within a process can be assumed as an acceptable metric. However, in domain of semantic relations there are many different aspects from which data and requirement are chosen in this paper. We choose data, because any service operation needs data and the result of that operation also manipulates data. Without data, services and even processes are meaningless, because data is the place that stores the effect of services and processes. The third aspect is requirement. Requirements are important, for three reasons: first, the objective of services is to satisfy requirements, which are obtained from goals, so considering requirements helps us identify services that match our needs. Second, when functions satisfying similar requirements are collected in a service, the reusability of the whole system can be increased, because workflows have several similar requirements and when you identify services for those requirements you can simply reuse those services for other workflows in system. Finally, requirements change frequently and we have to manage and apply those changes, so if all functions related to the same requirement are collected in a service, then changing the requirement only affects that service.

As a result, although there are several more aspects, which can be considered to identify services, we only consider the most important ones that every system needs to deal with.

On the other side of the coin Semantic Web paradigm, which is a very hot subject and is growing very fast in resent years, can be used to identify services. The Semantic Web is a vision of a Web of meaningful contents and services, which can be interpreted by computer programs [20] in order to achieve process automation and service orchestration and choreography.

Ontology is a key concept in Semantic Web paradigm. Ontology typically provides a vocabulary that describes a domain of interest and a specification of terms meaning used in the vocabulary [21]. Ontologies have been developed within the Knowledge Modeling research community [22] in order to facilitate knowledge sharing and reuse. The service ontology essentially is integrated at the knowledge-level the information which has been defined by Web services standards, such as UDDI and WSDL with related domain knowledge. The first essential step for an efficient interoperability is the definition of a domain ontology [23]. OWL-S [24] is based upon the Web Ontology Language (OWL). More precisely it is a specific OWL ontology, which is structured for describing service attributes. A number of capability matching algorithms have been proposed for OWL-S [25] to perform matching between requirements, resources and tasks using reasoning techniques. In addition, ontology matching is a solution to the semantic heterogeneity problem. It finds correspondences between semantically related entities of ontologies [21].

Although Semantic Web can be used to identify services, researchers are most interested to use this strategy to discover, describe and compose services [26]. On the other hand, although services can be identified using ontology, finding an ontology, which is acceptable by everyone, is a hard task. But some matching algorithms, such as those described in [27] and [28], assume the availability of ontologies of functionalities to express capabilities. To overcome this problem some methods such as linked open model [29] try to reduce the rule of ontologies. Linked open model, links different models using metamodels. It can be used to transfer model structure and contents between different compatible notations. Linked open model strategy can be used to identify services semantically, but the computational aspect is completely missing.

In the method proposed in this paper, three task-task matrices resulting from tasks dependency based on business processes, requirements and data are composed to detect appropriate functionalities as candidate services. Services are identified as cohesive, independent and reusable components using clustering techniques and a genetic algorithm. In this way, being cohesive does not necessarily mean being composed of highly interacting components. A service may be composed of a set of tasks that are inter-related through shared access to data object or supporting the same requirements.

The remaining parts of this paper are organized as follows: Section 2 introduces the related works in the domain of service identification. In Section 3 details about the proposed method for the semi-automatic identification of services are provided. In Section 4, the proposed method is compared to other existing methods and evaluated based on several qualitative and quantitative criteria. Finally, Section 5 concludes the paper.

2. Related Works

In last decade a large number of methods are presented to identify services. Identifying appropriate services can help to fill the gap between business and service domains [30]. A comparison of more than 30 known methods from the points of view of approach, strategy, technique, input and output is provided in [2] . Also [31,32,33,34,35,4] present different surveys on service identification methods form various aspects. Because of diversity and multiplicity of these methods, in this section only well-known methods that use business processes, goals or data as their inputs or identification strategies are studied. Furthermore automated methods are reviewed as well as semi-automated methods.

2.1. Business Process-driven Methods

Business process decomposition is a common strategy in service identification domain. Based on the study on the input of more than 60 service identification methods in [36], business process is the most popular input to identify services. These methods usually decompose business processes, cluster tasks and finally introduce each cluster as a service. A formal method is introduced in [8] to identify services by analyzing business processes and using graph clustering technique. This method uses hierarchical clustering algorithm to identify services with the maximum cohesion and minimum coupling. Ignoring other aspects of tasks dependency except tasks inter-connections to identify services is the main challenge of this method. Heuristics are applied by semantic analysis of business elements such as business rules and business requirements, and syntax analysis of process model is used as service identification strategy by [37]. This method neither provides detailed information about its heuristics, nor presents any automatic way to identify services. Also [38] provides a complete version of [37] and introduces 28 various heuristics to identify services. Most of these heuristics are based on business processes, however data and requirements are mentioned in a few of them. The fine-grained granularity of services and lack of automation are the most important problems of this method [39]. Method in [40] decomposes business processes in order to identify services, but there is no further information provided about identification metrics. Also this method was not applied to any case study and did not use any modeling standard such as BPMN or UML. Although [41] introduces its method using a comprehensive case study and considers business architecture to cover requirements, ignoring cohesion and lack of providing details are the shortcomings of this method. Creating a matrix to analyze dependency between business process and business entity and classifying business processes accessing similar entities is presented by [42]. This method does not investigate the connections between tasks within business processes. As a result, lack of considering other aspects of business, not providing detailed information, and lack of an automatic way to identify services are the main difficulties of most of these methods.

2.2. Goal-driven Methods

The importance of goal in software development makes goal-driven strategy useful to identify services. However the difficulty of goals expression is yet the major challenge of this strategy. In [43] a method to identify and manage software services using goals and requirements is proposed. Authors present a strategic dependency model to specify service relations and their interaction with business actor. Finally services are identified based on the relation between goals and roles. In this method goals are determined based only on roles. In [6] service identification starts with goal-service modeling. Goals are decomposed in several levels to identify services in the last level of model. Also [15] traces business goals in supporting services by creating a goal graph. In this method to satisfy each goal, several services are needed. A multi perspective method based on business processes, use-cases, legacy systems, and goal-service modeling introduced in [13] does not clarify details about its identification process. Using a pair of goal and scenario is introduced by [14]. The purposes of this method are explaining how to transform business process to service and presenting service interactions to obtain business agility and business goals. Services are defined in analysis phase considering business change and business goal. A flexible process design followed by service identification for product life cycle management application is presented in [44]. Similar to [6], this service identification method considers both business process and goal, but does not provide any detailed information about their steps. As a result it can be said that most goal-driven service identification methods identify services manually and also do not consider goals levels.

2.3. Data-driven Methods

Various methods consider data in terms of object or entity to identify services. Business entities are classified based on their lifetime, handled by organization units [39]. Each resulting class is then considered as a candidate service. An entity shared among business activities is also used as a means for identifying the activities as a service [45]. However, there are certain situations in which the activities are commonly applied to relate a number of entities [17]. In the approach proposed in [46], relationships among entities are considered by relating entities that are accessed by the same operation. However, the strengths of relationships are not examined in this approach. Measuring the cohesiveness of a service through entities, entity-entity and entity-activity matrices is proposed in [17], but this metric can be measured only after identifying services and is not helpful to identify services. An artifact-centric approach based on master data life cycle, rather than process is introduced in [19] . In this method a UML class diagram is modeled to represent master data and finally each master data is considered as an entity service. Although data plays a major role in service identification, the lack of consideration of process aspect is obvious in that method. Moreover service reuse is not taken into account.

2.4. Automated and Semi-Automated Methods

Besides these three categories, there are a few number of automated and semi-automated service identification methods. Using spanning trees technique is one of formal methods for service identification. In this method relations between business elements are calculated and spanning tree is used to collect elements in services [47]. Spanning tree-based methods are greedy, so the result may not be an optimal solution. Furthermore authors did not provide any case study to verify their work. ASIM [48] considers entities as an input to convert business model to service model. Authors use CRUD matrix to assign weights to access types of entities. Lack of attention to other dependencies between tasks is evident in this method. The method in [49] assumes a set of business processes as the input and identifies services automatically using multi-objective genetic algorithm. Although this method focuses on design metrics, the reuse metric is ignored. Finally [50] provides a semi-automated method for inter-organizational service identification supporting business process and data. This method focuses on data flow and calculates task dependency based on data. Also it refines identified services. Nonetheless authors do not investigate tasks inter-connection.

3. Service Identification Method

The method proposed in this article identifies services using business processes models, goals model and data model. The method consists of four main steps. In step 1, the business processes for the target system are modeled and based on tasks inter-connections within models, a task-task matrix for all business processes of system is extracted. It should be noted that each workflow system comprises several business processes. To identify services, these business processes are considered at once, because repeated tasks can be found in different processes. So, regarding all business processes simultaneously, these repeated tasks and their connections are taken into account. In step 2, using goals modeling technique, requirements of the system are extracted and then by considering connections between requirements and goals, and also dependencies between requirements and their supporting tasks, another task-task matrix is created. In the third step, the data model, which shows objects, roles and their associations, is built. Then, considering the access types of tasks to objects and roles that perform tasks, the third task-task matrix is constructed. Finally and in step 4, these task-task matrices are combined and services are identified using genetic algorithm and Turbo-MQ fitness function.

3.1. Modeling Business Processes

In the first step, business processes, which show the workflows of a system, are modeled. Each business process comprises a set of tasks, connections between tasks, gateways, events and roles that perform tasks. To describe the proposed method, a supplier system is considered as a motivation example. This system has several processes, however in this article only the process of ”Plan Approval” is taken into account. Plan Approval process is explained as follow.

Motivation Example: Supplier system needs yearly estimations for purchasing required parts. Estimations are written by estimator and notified to employees. Each time, based on the estimation, employee provides a plan and sends it to the evaluator. The evaluator checks the compatibility of plan with estimation from financial point. If the plan is not compatible to estimation or if it is not acceptable, the plan is returned to the employee for editing, else the evaluator evaluates the quality of the plan. Again, if its quality is not sufficient, the plan returns to the employee for editing, otherwise, the evaluator asks the employee to prepare a document. After preparing the document, the estimator checks it, if he confirms the document, he signs it and the process ends, otherwise the document including his comments is returned to the employee to be edited.

Figure 1 shows the business process model for Plan Approval process using BPMN 2.0 standard. Simplicity, Expressiveness, and high usage have been the main advantages of this standard, compared with other methods of business process modeling [51].

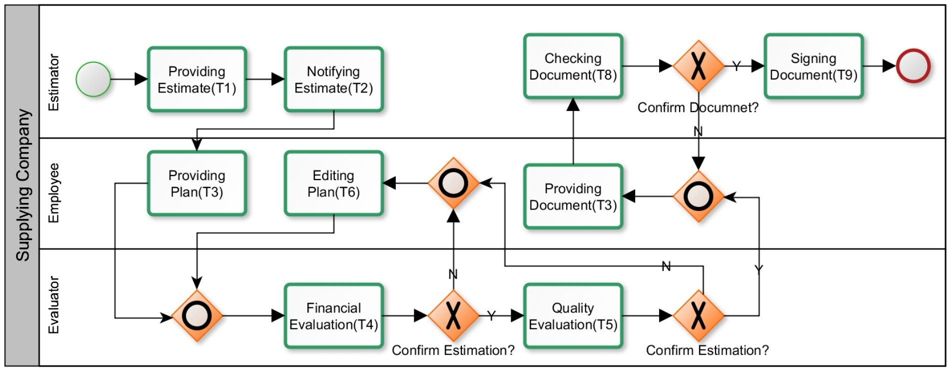


Fig. 1. Business Process Model for Plan Approval Process

Using business process models, a task-task matrix can be automatically extracted. Each row and column of this matrix addresses a separate task in the business process models. The task-task matrix is called TT1. The element $[TT1]_{i,j}$ is a positive integer representing the number of outgoing edges from task T_i to T_j within business process models. Because all business processes are considered at once, it is possible that two tasks have several connections in different models, so the total number of connections should be considered. Furthermore, it should be noted that gateways and events are not considered, e.g., if there are only events or gateways between two tasks, these two tasks are considered as inter-connected tasks.

Using Algorithm 1 the first task-task matrix for Plan Approval Process can be built as Table 1.

Table 1. First Task-Task Matrix for Plan Approval Process

	T1	T2	T3	T4	T5	T6	T7	T8	T9
T1	0	1	0	0	0	0	0	0	0
T2	0	0	1	0	0	0	0	0	0
T3	0	0	0	1	0	0	0	0	0
T4	0	0	0	0	1	1	0	0	0
T5	0	0	0	0	0	1	1	0	0
T6	0	0	0	1	0	0	0	0	0
T7	0	0	0	0	0	0	0	1	0
T8	0	0	0	0	0	0	1	0	1
T9	0	0	0	0	0	0	0	0	0

Algorithm 1 Creating First Task-Task Matrix

Input: Business Process Models comprise set of taks T, set of events E, set of gateway G, set of edges E
Output: TT1 Matrix

for all Event e (e is not the start event, $e \notin$ end events) with predecessor node p_e and successor node s_e **do**
    $remove$ **e**
    add edge(p_e, s_e)
end for
for all gateway g with predecessor nodes $p_1, p_2, ..., p_n$ and successor nodes $s_1, s_2, ..., s_m$ **do**
    $remove$ **g**
    for $i \leftarrow 1$ to n **do**
        for $j \leftarrow 1$ to m **do**
            add edge(p_i, s_j)
        end for
    end for
end for
for all Tasks pair t_i, t_j **do**
    $[TT1]_{i,j}$= number of edge(t_i, t_j)
end for

3.2. Modeling Goals and Requirements

In the second step, considering the dependencies of tasks and requirements the second task-task matrix is built. In order to fulfill the given goal, requirements are extracted first using goals modeling technique. Then the relations between requirements are valued based on their levels. Finally using these values and dependencies between tasks and requirements, which are determined in task-requirements matrix, the second task-task matrix is specified.

Goals model represents goals, objectives and requirements of the system. A goal is a purpose to be achieved by the system under consideration [52]. Goals modeling is one of the requirements elicitation techniques that helps system analyst to recognize all requirements to be fulfilled by software product. In a goals model high-level goals are decomposed to sub-goals until requirements are extracted. Creating goals model is a difficult task and needs cooperation of representatives of developers, business workers and even users.

In this paper the goals model is created in a simple way and goals are shown without any property. As it can be seen in Figure 2, the high-level goal of the motivation example is Creating Supplier System. This goal can be obtained by Warehousing Supporting, Plan Approval Supporting and Purchasing Part Support sub-goals. While the first and the last are out of the studied process, Plan Approval Supporting is decomposed in several steps and finally requirements are extracted as the leaves of the model.

Using goals model, the relations between requirements can be valued. The relation between any pair of requirements R_i and R_j is determined via computing the maximum distance between levels of R_i and R_j, and level of their lowest common ancestor in goals

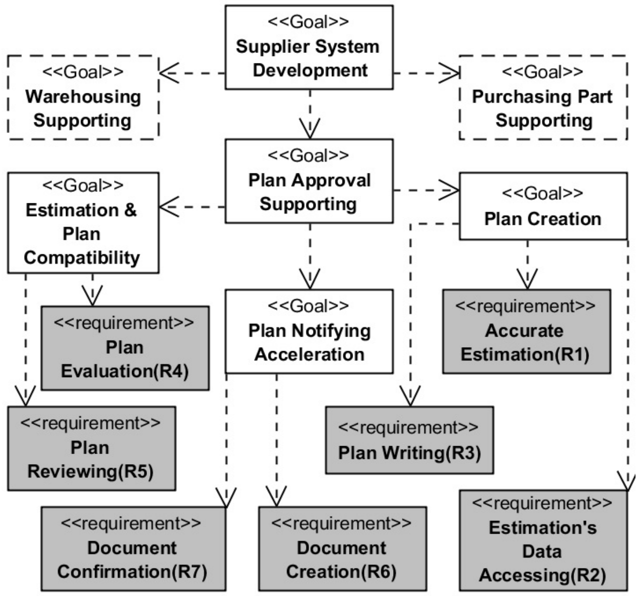


Fig. 2. Goals Model for Creating Supplier System

model. In Algorithm 2, *LCA* returns the lower common ancestor of two nodes and *Distance* calculates level differences between two nodes.

Algorithm 2 Creating RR Matrix

Input: Goals Model comprises set of Goals G, set of Requirements R
Output: RR Matrix

for all Requirements pair r_i, r_j **do**
  $G_{lca} \leftarrow \text{LCA}(r_i r_j)$
  $X \leftarrow max(\text{DISTANCE}(r_i, G_{lca}), \text{DISTANCE}(r_j, G_{lca}))$
  $[RR]_{i,j} \leftarrow \frac{1}{2^X}$
end for

Table 2 demonstrates the requirement-requirement (RR) matrix for Plan Approval process.

Displaying dependencies between requirements and tasks is the main purpose of task-requirement matrix. In this matrix, columns indicate tasks and rows show requirements. Accordingly, for each relevant task and requirement, which means a task supports a requirement, ✓sign is put in corresponding element in the matrix.

Table 3 shows the task-requirement (TR) Matrix for Plan Approval process.

Finally, second task-task matrix, representing tasks dependencies based on supporting requirements, is built. Two tasks may be related depending on whether they support the same requirement or are descendants of the same goal. When two tasks support same

Table 2. Requirement-Requirement Matrix for Plan Approval Process

	R1	R2	R3	R4	R5	R6	R7
R1	1	0.5	0.5	0.25	0.25	0.25	0.25
R2	0.5	1	0.5	0.25	0.25	0.25	0.25
R3	0.5	0.5	1	0.25	0.25	0.25	0.25
R4	0.25	0.25	0.25	1	0.5	0.25	0.25
R5	0.25	0.25	0.25	0.5	1	0.25	0.25
R6	0.25	0.25	0.25	0.25	0.25	1	0.5
R7	0.25	0.25	0.25	0.25	0.25	0.5	1

Table 3. Task-Requirement Matrix for Plan Approval Process

	R1	R2	R3	R4	R5	R6	R7
T1	✓	-	-	-	-	-	-
T2	-	✓	-	-	-	-	-
T3	-	-	✓	-	-	-	-
T4	-	-	-	✓	-	-	-
T5	-	-	-	✓	-	-	-
T6	-	-	-	-	✓	-	-
T7	-	-	-	-	-	✓	-
T8	-	-	-	-	-	-	✓
T9	-	-	-	-	-	-	✓

requirements or different requirements with a same ancestor, they are conceptually inter-related. To determine this type of tasks inter-relations for each two tasks, T_i and T_j, using TR matrix, all their related requirements are determined at first, e.g., G_x and G_y are related to T_i and G_w and G_z are related to T_j, respectively. Then, all different related elements of these requirements in RR matrix ($[RR]_{x,w}$, $[RR]_{x,z}$, $[RR]_{y,w}$ and $[RR]_{y,z}$) are considered and the element with the highest value is selected as the $[TT2]_{i,j}$ using the Algorithm 3.

Algorithm 3 Creating Second Task-Task Matrix

Input: TR Matrix, RR Matrix
Output: TT2 Matrix

```
for all Tasks pair t_i, t_j do
    ReqSet = φ
    for all Requirements pair R_i, R_j do
        if [TR]_{i,x} = [TR]_{j,y} = ✓ then
            ReqSet ←ReqSet ⋃ [RR]_{x,y}
        end if
    end for
    [TT2]_{i,j} = Max(x) where x ∈ ReqSet
end for
```

Table 4 shows the second task-task matrix for Plan Approval process.

Table 4. Second Task-Task Matrix for Plan Approval Process

	T1	T2	T3	T4	T5	T6	T7	T8	T9
T1	0	0.5	0.5	0.25	0.25	0.25	0.25	0.25	0.25
T2	0.5	0	0.5	0.25	0.25	0.25	0.25	0.25	0.25
T3	0.5	0.5	0	0.25	0.25	0.25	0.25	0.25	0.25
T4	0.25	0.25	0.25	0	1	0.5	0.25	0.25	0.25
T5	0.25	0.25	0.25	1	0	0.5	0.25	0.25	0.25
T6	0.25	0.25	0.25	0.5	0.5	0	0.25	0.25	0.25
T7	0.25	0.25	0.25	0.25	0.25	0.25	0	0.5	0.5
T8	0.25	0.25	0.25	0.25	0.25	0.25	0.5	0	1
T9	0.25	0.25	0.25	0.25	0.25	0.25	0.5	1	0

3.3. Modeling Data

Data is the third criterion for service identification. Here, data means objects, which are related to tasks within business processes models. In this step, first, data model is created. This model shows object-types and roles as role-type. Also their associations are specified. Then, based on relations between objects and tasks and also the permission type of roles on tasks, the task-object (TO) matrix is constructed. Finally, using this matrix and considering accessing to same objects or being accessed by the same role, the third task-task matrix is built.

Figure 3 demonstrates data model for Plan Approval process. As mentioned before for each Estimation, several plans are required and for each plan several evaluations are written. Also plan and document has a one-to-one relation. On the other hand, each estimator has been estimating several estimations and signing several documents. Employees write several plans and documents. The relation between evaluation and evaluator is many-to-many.

Relations between object-types and role-types can be seen in Table 5. In this table 'W' means that the corresponding role has write permission on the related object and 'R' stands for read permission.

Table 5. Role-Object Matrix for Plan Approval Process

	O1	O2	O3	O4
U1	W	R	R	W
U2	R	W	R	W
U3	R	R	W	-

Having this matrix and the business process models, task-object matrix can be created easily. In task-object matrix, each row shows a separate task and each column indicates an object-type or role-types. As it can be seen in Table 6, the access types of relevant objects and role which performed the task are specified for each task .

Finally, to create the third task-task matrix, for every pair of tasks in business process models, if these two tasks have access to the same object, the average access type value

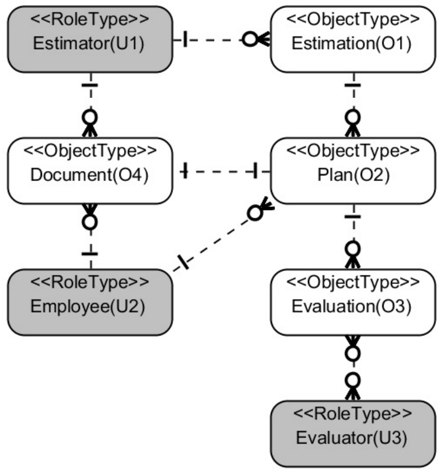


Fig. 3. Data Model for Plan Approval Process

Table 6. Task-Object Matrix for Plan Approval Process

	O1	O2	O3	O4	U1	U2	U3
T1	W	-	-	-	✓	-	-
T2	W	-	-	-	✓	-	-
T3	R	W	-	-	-	✓	-
T4	R	R	W	-	-	-	✓
T5	R	R	W	-	-	-	✓
T6	R	W	R	-	-	✓	-
T7	-	-	-	W	-	✓	-
T8	-	-	-	W	✓	-	-
T9	-	-	-	W	✓	-	-

of these tasks are computed. The value of Write and Read is considered as 1 and 0.5 respectively, because for each write two accesses to object are needed. Also if these two tasks are performed by one role, the value of one is summed with the last value and placed in the relevant element of the third task-task matrix according to the Algorithm 4.

Table 7 shows the third task-task matrix for Plan Approval process.

3.4. Identifying Services

In order to determine the degree of relations between tasks, the three task-task matrices, obtained in the last three steps are combined using Eq 1.

$$[TT]_{i,j} = \alpha[TT1]_{i,j} + \beta[TT2]_{i,j} + \gamma[TT3]_{i,j} \tag{1}$$

The important issue here is how to weigh these matrices. To specify these weights the meaning of each value should be noted at first. As mentioned before, for each pair of

Algorithm 4 Creating Third Task-Task Matrix

Input: TO Matrix
Output: TT3 Matrix

```
for all Object o, Role u, Task i, Task j in TO Matrix do
    SUM ← 0
    if [TO]_{i,o} ∈ {R,W} & [TO]_{j,o} ∈{R,W} then
        SUM ← (VALUE(i,o) + VALUE(j,o))/2
        if [TO]_{i,u} = [TO]_{j,u} = ✓ then
            SUM ← SUM + 1
        end if
    end if
    [TT3]_{i,j} = [TT3]_{j,i} = SUM
end for
procedure VALUE(x, y)
    if [TO]_{x,y} = W then
return 1
    else
        if [TO]_{x,y} = R then
return 0.5
        end if
    end if
end procedure
```

tasks T_i and T_j value "1" in the first task-task matrix means an outgoing edge form T_i to T_j. In second task-task matrix this value means T_i and T_j support the same requirement and in third task-task matrix it means T_i and T_j have write permission to the same data object or are performed by the same role. Furthermore the second and the third matrices are symmetric matrices and each value is repeated in symmetrical element.

To determine these values, at first, ten domain experts are asked to say their opinions. Actually the value of α is assumed constant and equal to 1 and the values of β and γ are asked. Table 8 shows their opinions about the values of β and γ.

In addition to experts' opinions, a training set, which contains 20 various processes from various domains, is used. For each process of this training set, while considering cohesion, loose coupling, reusability, and granularity criteria, domain experts identify services. For all these processes the proposed method is applied and by solving corresponding equations for each process, different values of β and γ are calculated. As mentioned before, the value of α is assumed constant and equal to 1. Also the ranges of β and γ are limited to the ranges of experts' opinions for these two parameters: $\beta \in$ [0.2, 0.8] and $\gamma \in$ [0.2, 1]. The bounds are rounded to the nearest tenth. The answer of each equation is the point that identified services correctly and also has the highest fitness function value between the correct answers.

To explain the method of obtaining β and γ value, consider Figure 4. This figure shows the relations between candidates β and γ values for a sample process. In this process for each $\beta \in \{0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8\}$ using different values of $\gamma \in \{0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1\}$ the γ value that identifies services correctly and also has the highest fitness function value is calculated. The label of each point shows the fitness function value. Then between these different points the point with maximum fitness function value

Table 7. Third Task-Task Matrix for Plan Approval Process

	T1	T2	T3	T4	T5	T6	T7	T8	T9
T1	0	2	0.5	0.5	0.5	0.5	0	1	1
T2	2	0	0.5	0.5	0.5	0.5	0	1	1
T3	0.5	0.5	0	1	1	2.5	1	0	0
T4	0.5	0.5	1	0	3	1.5	0	0	0
T5	0.5	0.5	1	3	0	1.5	0	0	0
T6	0.5	0.5	2.5	1.5	1.5	0	1	0	0
T7	0	0	1	0	0	1	0	1	1
T8	1	1	0	0	0	0	1	0	2
T9	1	1	0	0	0	0	1	2	0

Table 8. Experts' Opinions about metrics weights

Expert	α	β	γ	Expert	α	β	γ
E1	1	0.2	0.5	E6	1	0.25	0.33
E2	1	0.75	0.75	E7	1	0.25	0.5
E3	1	0.25	0.5	E8	1	0.5	0.66
E4	1	0.33	0.33	E9	1	0.25	0.5
E5	1	0.33	0.66	E10	1	0.33	0.66

is selected as the answer. As it can be seen in point of [0.4, 0.5] this process has its maximum value for fitness function, so β = 0.4 and γ = 0.5 are the answers of equation for this sample process.

In Table 9 the best values for all training set processes are calculated.

Table 9. α, β and γ Values for Processes of the Training Set

	α	β	γ		α	β	γ
P1	1	0.4	0.5	P11	1	0.3	0.7
P2	1	0.2	0.5	P12	1	0.4	0.4
P3	1	0.3	0.4	P13	1	0.4	0.5
P4	1	0.3	0.5	P14	1	0.2	0.2
P5	1	0.4	0.6	P15	1	0.3	0.4
P6	1	0.5	0.4	P16	1	0.3	0.5
P7	1	0.2	0.6	P17	1	0.2	0.6
P8	1	0.2	0.5	P18	1	0.2	0.5
P9	1	0.3	0.6	P19	1	0.2	0.4
P10	1	0.3	0.5	P20	1	0.3	0.6

Finally using the average of experts' opinions and training set results the approximate values of **α=1, β=0.3 and γ=0.5** are determined. These answers are rounded to the nearest tenth. Table 10 represents the final task-task matrix, which is valued by the combination of the first, second, and third matrix.

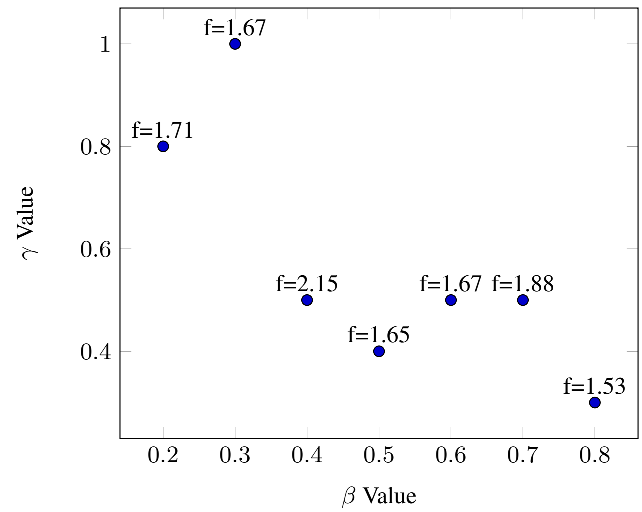


Fig. 4. β and γ values for a sample process

Table 10. Final Task-Task Matrix for Plan Approval Process

	T1	T2	T3	T4	T5	T6	T7	T8	T9
T1	0	2.15	0.4	0.325	0.325	0.325	0.075	0.575	0.575
T2	1.15	0	1.4	0.325	0.325	0.325	0.075	0.575	0.575
T3	0.4	0.4	0	1.575	0.575	1.325	0.575	0.075	0.075
T4	0.325	0.325	0.575	0	2.8	1.9	0.075	0.075	0.075
T5	0.325	0.325	0.575	1.8	0	1.9	1.075	0.075	0.075
T6	0.325	0.325	1.325	1.9	0.9	0	0.575	0.075	0.075
T7	0.075	0.075	0.575	0.075	0.075	0.575	0	1.65	0.65
T8	0.575	0.575	0.075	0.075	0.075	0.075	1.65	0	2.3
T9	0.575	0.575	0.075	0.075	0.075	0.075	0.65	1.3	0

To identify services, final task-task matrix is clustered using a genetic algorithm and turbo-MQ [53] as fitness function. Each cluster is considered as a service. To do this, each task is assumed as a node and tasks that are highly cohesive and loosely coupled are considered as a cluster. In other words using turbo-MQ fitness function, cluster inter- and intra- connectivities are calculated. Eq 2 represents the Turbo-MQ fitness function.

$$
\begin{aligned}
&Turbo-MQ = \sum_{i=1}^{k} CF_i \\
&CF_i = \begin{cases} 0 & \mu = 0 \\ \frac{2\mu_i}{2\mu_i + \sum_{i=1, i\neq j}^{k} (\delta_{i,j} + \delta_{j,i})} & \text{otherwise} \end{cases}
\end{aligned}
\tag{2}
$$

In this relation, CF_i indicates the cluster number i, μ_i indicates the number of intra-relations between tasks within the cluster i and $\delta_{i,j}$ represents the number of inter-relations between tasks in cluster i and cluster j. The turbo-MQ function is used as the fitness function for a genetic clustering algorithm [53]. The genetic algorithm is applied to an initial population of 90 randomly selected clustering for 900 generations while the crossover and mutation probabilities are 0.6 and 0.02, respectively. Figure 5 shows the resulted clusters. In this figure each oval is a task and each rectangle represents a cluster.

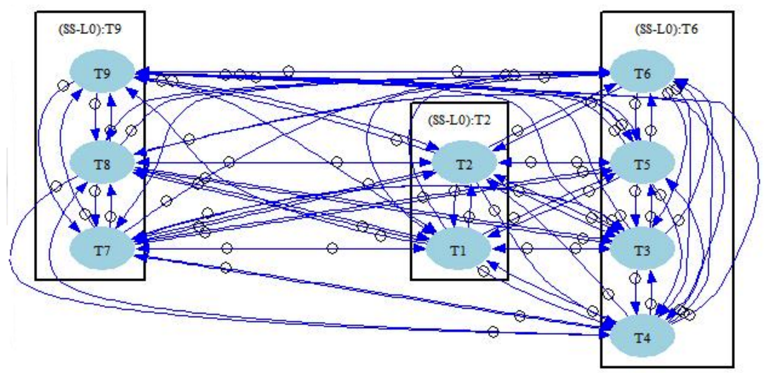


Fig. 5. Identified Services

4. Evaluation

In this section the proposed method is evaluated from quantitative and qualitative aspects. To evaluate the correctness of identified services, five users are asked to identify services from six different processes, Then the average of their results accuracy are compared to the accuracy of the proposed method. In this context accuracy means the number of tasks that are clustered in the correct service to the total number of tasks. Figure 6 shows the results. As it can be seen, the accuracy of the proposed method has significant superiority over the users in all cases.

The structure of process affects the accuracy of service identification method. Structure of a process can be defined as the size or the complexity of the process [50]. To measure the accuracy of the proposed method, at first, several users were asked to identify services from seven processes with different sizes. The number of tasks are assumed as the size of process. As it can be seen in Figure 7 the accuracy of the proposed method is almost independent of the size of process.

The next evaluation is based on process complexity. To this end the number of gateways are supposed as the process complexity and similar to the previous evaluations, the accuracy of the proposed method is compared to the accuracy of users. Figure 8 demonstrates the results of this comparison.

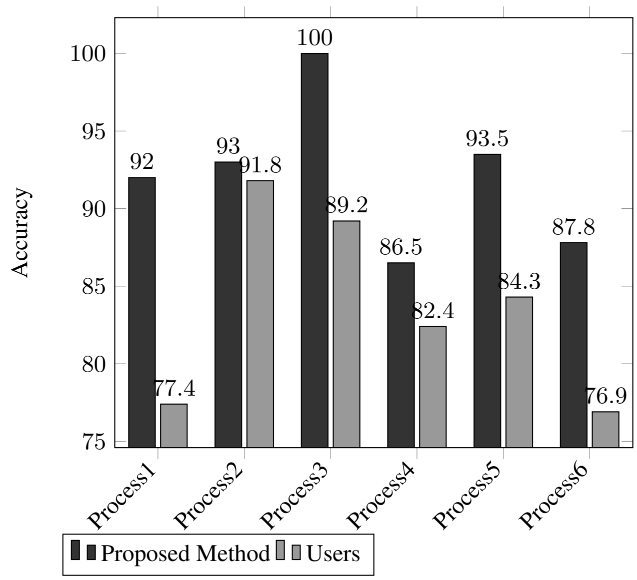


Fig. 6. Accuracy Comparison using several processes

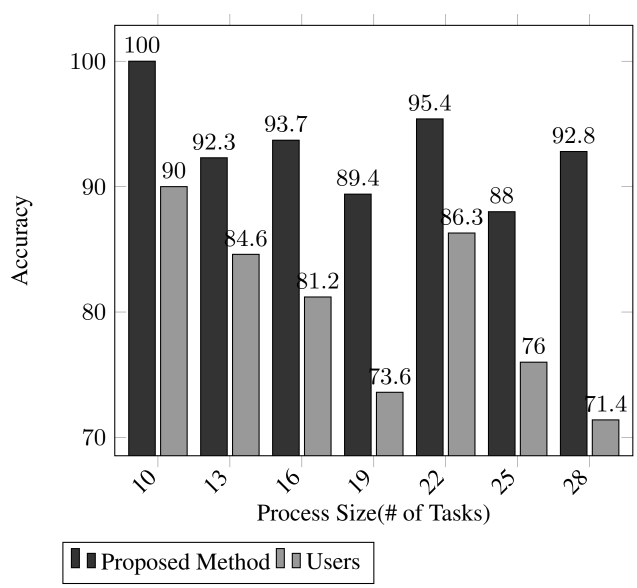


Fig. 7. Relation Between Accuracy and Process Size

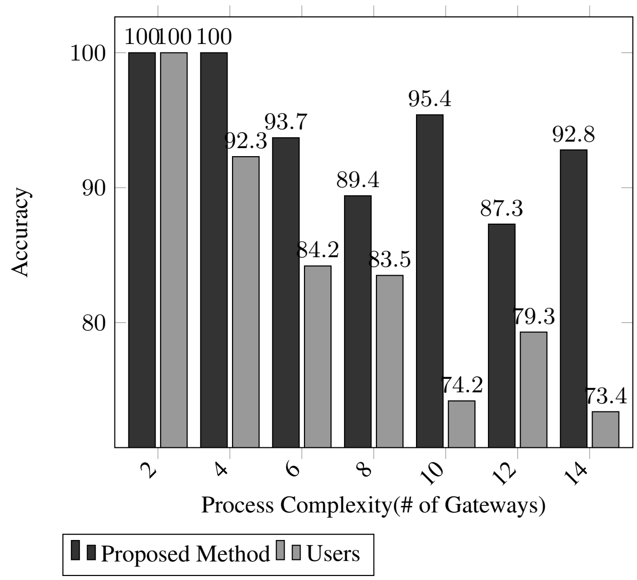


Fig. 8. Relation Between Accuracy and Process Complexity

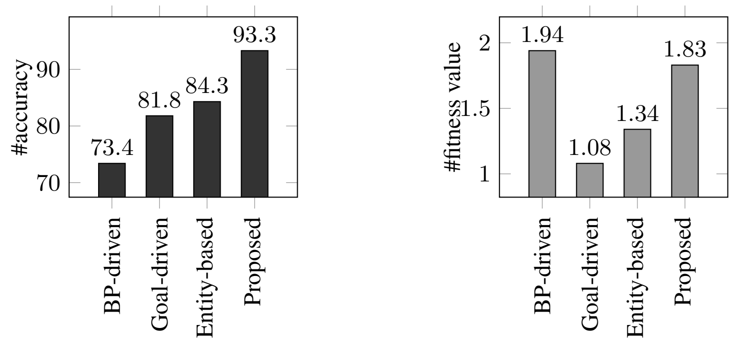
In the last quantitative evaluation, the proposed method is compared to several other methods from accuracy and fitness value points of view . To this end business process-driven, goal-driven, and entity-based service identification methods are selected and applied to ten different processes. Finally the average of their results are compared to the results of the proposed method. Figure 9(a) and Figure 9(b) represent the accuracy and fitness value results.

As it can be seen in Figure 9, the accuracy of the proposed method is higher than other methods, but in case of fitness function, business process-driven method has the highest fitness value. Since Turbo-MQ only takes the structural relations between tasks into account, the number of clusters inter-relations are decreased and eventually the fitness value is increased. Nonetheless, since this method does not consider reuse metric, its accuracy is low.

Cohesion, loose coupling, reusability and granularity are four major metrics that are applied to measure the quality of service identification methods [54]. These metrics have been applied to compare the proposed method with some other well-known service identification methods. Furthermore automation is another metric that could be used to compare service identification methods. As shown in Table 11, the proposed method supports all these four metrics and in addition it is automated and has multi-aspect strategy to identify services.

5. Conclusion and Future Work

This article aims to provide a semi-automatic multifaceted method to identify independent collection of highly inter-related tasks as services. To this end tasks inter-relations are



(a) Accuracy Comp. **(b)** Fitness value Comp.

Fig. 9. Comparison with Related Work

measured not only regarding inter-connections between tasks in business process models, but also considering tasks dependency in terms of supporting the same requirements as well as accessing to same data. Taking these various aspects into account needs the definition of a common language that task-task matrix plays this role in the proposed method. Since the connections between tasks show a control flow between them, these connections must be considered to identify loosely coupled services. In other words placing two inter-connected tasks in two separated services means a call dependency between these two services. On the other hand, reusability is an important property of qualified services. Considering the reuse of services needs attention to conceptual relations between tasks, therefore tasks that support a same requirement or sub-goals of a same goal are considered as inter-related tasks. While goals and requirements of a business are repeated in different business processes and systems, if tasks supporting a same goal form a service, by repeating this goal in any other systems, the produced service can be used there. Furthermore if the goal or requirement is changed, the least number of services needs to be change. Finally considering common data objects between tasks can increase the reuse of services and decrease the services coupling. Combination of these three aspects needs the accurate computation to determine the weight of each one in the final equation. To fulfill this, several domain experts and a training dataset, which consists of some business processes, are used. By determining these weights the final task-task matrix is extracted and tasks are clustered using a genetic algorithm and Turbo-MQ fitness function. It should be noted that these weights can be changed depending on the the domain. The resulted services are evaluated from different points of view and the results show a significant excellence in comparison with other methods.

Although in the proposed method three aspects, which are process, data, and requirement, are considered, the proposed method is extendable if there is any other aspect such as resources or ownership that someone wants to take into account. In order to add a new aspect we just need to find a relation between the tasks of process and elements of that aspect. For example suppose that we have several resources that can be accessed by service operations (process tasks) and we want to identify services in a way that there is a high probability of accessing the same resource by all service operations. Simply we can create a task-resource matrix, which shows the relation between tasks and resources

Table 11. Evaluation of Common Service Identification Method

	Strategy	Technique	Input	Standards	Multi-aspect	Automation
Fareghzadeh, 2008	BPD,GD, Existing Supply	Analysis	UCM, LS	UML	+	-
Kim, 2008	Goal Scenario	Guideline	BP, Goal	-	-	-
Levi, 2002	BPD, GD	Analysis	BP	UML	+	-
Huergo, 2014	BPD	artifact-centric	BP, MD	UML	+	-
Azevedo, 2014	BPD	Heuristics	BP,DD	EPC,FAD	+	-
Inaganti, 2007	BPD	Guideline	BP	-	-	-
Birkmeier, 2013	BPD	Heuristics	BP	-	-	-
Jamshidi, 2008	BPD, DD	Algorithm	BP	UML	+	o
Jain, 2010	BF	Graph Clustering	AD	-	-	+
Jamshidi, 2012	DD	Matrix Clustering	BP, CRUD	-	-	o
Kazemi, 2011	BPD	GA	BP	BPMN	-	+
Bianchini, 2014	BPD	Algorithm	BP	BPMN	+	o
(our)	BPD, GD, DD	GA, Clustering	BP, Goal	BPMN	+	o

In Table 11: BPD stands for Business Process Decomposition, DD stands for Data-driven, GD stands for Goal-driven, BF stands for Business Function, BP stands for Business Process, GA stands for Genetic Algorithm, LS stands for Legacy System, and finally AD stands for Application Domain. Also o in automation columns means semi-automated.

and different relations can have different weights. Also we may need another matrix that shows the relation between resources, if there is any. Finally based on these two matrices the task-task matrix for the process can be created. Different task-task matrices have different weights in final matrix obtained using training data or expert opinion. As a result it can be claimed that the proposed method is extendable and could be easily generalized to include any number of aspects. Therefore constructing a framework that can support all different aspects to identify services could be a possible future work. In that framework, required aspects should be selected by user and then based on those aspects, the framework generates task-task matrices and cluster tasks to identify services.

As mentioned before Semantic Web services play a significant role in today's service-oriented paradigm. The method that is proposed in this paper identifies services semi-automatically, but using Semantic Web, services can be identified automatically. Semantic Web can help us extract the relation between tasks and requirements and also tasks and data. Proposing an automated multifaceted method to identify services using Semantic Web could be another possible direction for future work.

References

1. Cai, Simin, Yan Liu, and Xiaoping Wang (2011) A Survey of Service Identification Strategies. In Services Computing Conference (APSCC), 2011 IEEE Asia-Pacific. pp. 464-470
2. Gu, Qing, and Patricia Lago (2010) Service identification methods: A systematic literature review. Towards a Service-Based Internet. pp. 37-50

3. Kramer, Frederik, Carsten Gorling, and Stefan Wind (2014) Service Identification-An Explorative Evaluation of Recent Methods. In 47th Hawaii International Conference on System Sciences (HICSS). pp. 1285-1295
4. Huergo, Rosane S., Paulo F. Pires, Flavia C. Delicato, Bruno Costa, Everton Cavalcante, and Thais Batista (2014) A systematic survey of service identification methods. Service Oriented Computing and Applications 8, no. 3. pp. 199-219
5. Rosen, Michael, Boris Lublinsky, Kevin T. Smith, and Marc J. Balcer (2008) Applied SOA: service-oriented architecture and design strategies. Wiley
6. Arsanjani, Ali, Shuvanker Ghosh, Abdul Allam, Tina Abdollah, Sella Ganapathy, and Kerrie Holley (2008) SOMA: A method for developing service-oriented solutions. IBM systems Journal 47, no. 3. pp. 377-396
7. Fensel, Dieter, and Christoph Bussler (2002) The web service modeling framework WSMF. Electronic Commerce Research and Applications 1, no. 2. pp. 113-137
8. Kim, Yukyong, and Kyung-Goo Doh (2009) Formal identification of right-grained services for service-oriented modeling. In Web Information Systems Engineering-WISE 2009, Springer Berlin Heidelberg. pp. 261-273
9. Weske, M (2007) BPM Concepts, Languages, Architectures. Springer, ISBN 978-3-540-73521-2
10. Mani, Senthil, Vibha S. Sinha, Noi Sukaviriya, and Thejaswini Ramachandra (2008) Using user interface design to enhance service identification. In ICWS'08, IEEE International Conference on Web Services. pp. 78-87
11. Hubbers, Jan-willem, Art Ligthart, and Linda Terlouw (2007) Ten ways to identify services. The SOA Magazine 13. pp. 1-7
12. Chaari, Sodki, Frdrique Biennier, Jol Favrel, and Chokri Benamar (2007) Towards a service-oriented enterprise based on business components identification. Enterprise Interoperability II. pp. 495-506
13. Fareghzadeh, Nafise (2008) Service identification approach to SOA development. In Proceedings of World Academy of Science, Engineering and Technology, vol. 35, pp. 258-266
14. Kim, Suntae, Minseong Kim, and Sooyong Park (2008) Service identification using goal and scenario in service oriented architecture" In APSEC'08, Software Engineering Conference, 15th Asia-Pacific. pp. 419-426
15. Levi, Keith, and Ali Arsanjani (2002) A goal-driven approach to enterprise component identification and specification. Communications of the ACM 45, no. 10. pp. 45-52
16. Iocola, P.:When Legacy Meets SOA (2007) Achieving Business Agility by Integrating New Technology with Existing Software Asset. In 1st Annual IEEE Systems Conference. pp. 1-8
17. Daghaghzadeh, Mohammad, Ahmad Baraani Dastjerdi, and Hossein Daghaghzadeh (2011) A Metric for Measuring Degree of Service Cohesion in Service-oriented Designs. International Journal of Computer Science, Vol. 8, Issue 5, No 2, pp.83-89
18. Reichert, Manfred (2012) Process and Data: Two Sides of the Same Coin?. In On the Move to Meaningful Internet Systems: OTM 2012, Springer Berlin Heidelberg. pp. 2-19
19. Huergo, Rosane S., Paulo F. Pires, and Flavia C. Delicato (2014) A method to identify services using master data and artifact-centric modeling approach. In Proceedings of the 29th Annual ACM Symposium on Applied Computing. pp. 1225-1230
20. Cabral, L., Domingue, J., Motta, E., Payne, T., & Hakimpour, F. (2004). Approaches to semantic web services: an overview and comparisons. In The semantic web: Research and applications. pp. 225-239
21. Shvaiko, P., & Euzenat, J. (2013). Ontology matching: state of the art and future challenges. IEEE Transactions on Knowledge and Data Engineering 25, no 1, pp. 158-176.
22. Gruber, T. R (1993) A translation approach to portable ontology specifications. Knowledge Acquisition 5, no. 2.

23. Masuch, N., Brock, P., & Albayrak, S. (2013). Semi-automated generation of semantic service descriptions. In Trends in Practical Applications of Agents and Multiagent Systems. pp. 155-162
24. Martin, D., Burstein, M., Hobbs, J., Lassila, O., McDermott, D., McIlraith, S., Narayanan, S., Paolucci, M., Parsia, B., Payne, T. and Sirin, E., (2004). OWL-S: Semantic markup for web services. W3C member submission, 22, 2007-04
25. Martin, David, Massimo Paolucci, Sheila McIlraith, Mark Burstein, Drew McDermott, Deborah McGuinness, Bijan Parsia et al. (2004). Bringing semantics to web services: The OWL-S approach. In Semantic Web Services and Web Process Composition. pp. 26-42
26. Amiri, Mohammad Javad, Khayati, A., Minaei-Bidgoli, B., & Kangavari, M. R. (2014). Development of the E-Commerce Dialogues using Dynamic Context-aware Web Services Composition. Turkish Journal of Engineering, 1, pp. 55-62
27. Lei Li and Ian Horrocks (2003) A Software Framework for Matchmaking Based on Semantic Web Technology. In Proc. of the Twelfth International World Wide Web Conference (WWW 2003), pp. 331-339
28. T. W. Malone, K. Crowston, B. P. Jintae Lee, C. Dellarocas, G. Wyner, J. Quimby, C. S. Osborn, A. Bernstein, G. Herman, M. Klein, and E. O'Donnell (1997) Tools for Inventing Organizations: Toward a Handbook of Organizational Processes. Management Science 45, no. 3. pp. 425-443
29. Karagiannis, D., & Buchmann, R. A. (2016). Linked Open Models: Extending Linked Open Data with conceptual model information. Information Systems, 56, pp. 174-197.
30. Ebrahimifard, A., Amiri, M. J., Arani, M. K., & Parsa, S. (2016) Mapping BPMN 2.0 Choreography to WS-CDL: A Systematic Method. Journal of E-Technology 7, no 1. pp. 1-23
31. Kohlborn, Thomas, Axel Korthaus, Taizan Chan, and Michael Rosemann (2009) Identification and analysis of business and software services-a consolidated approach. IEEE Transactions on Services Computing, 2, no. 1. pp. 50-64
32. Boerner R, Goeken M (2009) Service identification in SOA governance literature review and implications for a new method. In Proceedings of the 3rd IEEE international conference on digital ecosystems and technologies (DEST09). IEEE Computer Society, USA. pp. 588-593
33. Birkmeier D, Klckner S, Overhage S (2009) A survey of service identification approaches: classification framework, state of the art, and comparison. Enterp Model Inf Syst Archit 4(2). pp. 20-36
34. Kohlborn T, Korthaus A, Chan T, Rosemann M (2009) Service analysis-a critical assessment of the state of the art. In Proceedings of the 17th European conference on information systems (ECIS 2009). pp. 1583-1594
35. Vale T, Figueiredo GB, Almeida ES, Meira SLR (2012) A study on service identification methods for software product lines. In Proceedings of the 16th international software product line conference (SPLC 2012), vol 2. ACM, New York. pp. 156-163
36. Taei Zadeh, Ali, Muriati Mukhtar, Shahnorbanun Sahran, and M. R. Khabbazi (2012) A Systematic Input Selection for Service Identification. in SMEs, Journal of Applied Sciences 12, no. 12. pp. 1232-1244
37. Azevedo, Leonardo Guerreiro, Flvia Santoro, Fernanda Baio, Jairo Souza, Kate Revoredo, Vincios Pereira, and Isolda Herlain (2009) A method for service identification from business process models in a SOA approach. Enterprise, Business-Process and Information Systems Modeling. pp. 99-112
38. Azevedo, Leonardo Guerreiro, Flvia Santoro, Fernanda Baio, Thaissa Diirr, Alexandre Souza, Jairo Francisco de Souza, and Henrique Prado Sousa (2014) A Method for Bridging the Gap between Business Process Models and Services. iSys-Revista Brasileira de Sistemas de Informao 6. pp. 62-98
39. Yousef, Rana, and Mohammed Odeh (2011) A BPA-Based Approach for the Identification of SOA Candidate Software Services. In The 5th International Conference on Information Technology

40. Inaganti, Srikanth, and Gopala Krishna Behara (2007) Service identification: BPM and SOA handshake. BPTrends 3. pp. 1-12
41. Birkmeier, Dominik Q., Andreas Gehlert, Sven Overhage, and Sebastian Schlauderer (2013) Alignment of business and it architectures in the german federal government: A systematic method to identify services from business processes. In 46th Hawaii International Conference on System Sciences (HICSS). pp. 3848-3857
42. Jamshidi, Pooyan, Mohsen Sharifi, and Saeed Mansour (2008) To establish enterprise service model from enterprise business model. In SCC'08 IEEE International Conference on Services Computing. vol. 1, pp. 93-100
43. Grandry, Eric, Eric Dubois, Michel Picard, and Andr Rifaut (2008) Managing the alignment between business and software services requirements from a capability model perspective. In Towards a Service-Based Internet, Springer Berlin Heidelberg. pp. 171-182
44. Hachani, Safa, Lilia Gzara, and Herv Verjus (2013) A service-oriented approach for flexible process support within enterprises: application on PLM systems. Enterprise Information Systems 7, no. 1. pp. 79-99
45. Rostampour, A., A. Kazemi, F. Shams, A. Zamiri, and P. Jamshidi (2010) A metric for measuring the degree of entity-centric service cohesion. In IEEE International Conference on Service-oriented Computing and Applications (SOCA). pp. 1-5
46. Fan-Chao, Meng, Zhan Den-Chen, and Xu Xiao-Fei (2005) Business component identification of enterprise information system: a hierarchical clustering method. In ICEBE 2005, IEEE International Conference on e-Business Engineering. pp. 473-480
47. Jain, Hemant, Huimin Zhao, and Nageswara R. Chinta (2004) A spanning tree based approach to identifying web services. International Journal of Web Services Research (IJWSR) 1, no. 1. pp. 1-20
48. Jamshidi, P., S. Mansour, K. Sedighiani, S. Jamshidi, and F. Shams (2012) An Automated Service Identification Method. Technical Report, TR-ASER-2012-01. Automated Software Engineering Research Group, Shahid Beheshti University
49. Kazemi, Ali, Ali Rostampour, Pooyan Jamshidi, Eslam Nazemi, Fereidoon Shams, and Ali Nasirzadeh Azizkandi (2011) A Genetic Algorithm Based Approach to Service Identification. In 2011 IEEE World Congress on Services (SERVICES). pp. 339-346
50. Bianchini D, Cappiello C, De Antonellis V, Pernici B (2013) Service identification in interorganizational process design. IEEE Trans Serv Comput 7, no. 2. pp. 265-278
51. Chinosi, Michele, and Alberto Trombetta (2012) BPMN: An introduction to the standard. Computer Standards and Interfaces 34, no. 1. pp. 124-134
52. Van Lamsweerde, Axel (2001) Goal-oriented requirements engineering: A guided tour. In Fifth IEEE International Symposium on Requirements Engineering, Proceedings. pp. 249-262
53. Mitchell, Brian, Martin Traverso, and Spiros Mancoridis (2001) An architecture for distributing the computation of software clustering algorithms. In Working IEEE/IFIP Conference on Software Architecture. pp. 181-190
54. Papazoglou, Michael P., and Willem-Jan Van Den Heuvel (2006) Service-oriented design and development methodology. International Journal of Web Engineering and Technology 2, no. 4. pp. 412-442

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