Formalization of the Result of Web Services Remodularization Using Directed Labeled Graph

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Summary
In previous research we proceeded to remodularization of software architectures based of classes and packages and architectures based on components. We used approaches based on Formal Concept Analysis (FCA) [2] [6] [7], Oriented Graph [1] [4] and Relational Concept Analysis (RCA) [3]. The Web-based Information Systems (WIS) rely more frequently on a service-oriented architecture. This concept of architecture seeks to organize a set of isolated software applications into a set of interconnected services. Each one is accessible through the interfaces and standard communication protocols [5]. Last approaches, one using the concept of view and the point of view of web services was adopted [5] [8], others are based on Formal Concept Analysis (FCA) [2] and Relational concept analysis for remodularization at the level of web sevices [25] [26]. This paper is an extension of our work on remodularization at the level of web services [25] whose result has been a directed graph to be labeled for a better understanding by the software expert.
Keyword:
Remodularization, Web Services, Relational concept analysis (RCA), Directed Labeled Graph.

1. Introduction

Because of the inevitable evolution of software , their structure, which consists primary of modular abstractions , more precisely in web services, erode more less slowly. Fighting against this erosion, including modernizing structure though a consolidation of modular abstractions and a capitalization of entities discovered , has become a central problem of software engineering . Among the theories that may apply in this context, we can distinguish the formal concept analysis.
A Web Service is an application that is made available on the Internet by a service provider. This application allows the interoperability between users throughout the Web. This interoperability is ensured by using standards and open protocols [8] [9] [10].
The adoption of Web services is a major step in the development of interoperable information systems. The composition of services makes it possible to meet the increasingly complex needs of users by combining several Web services in the same business process. The use of Web services in the information systems based on the Web is increasingly frequent. These systems need to be adapted as more and more users with different preferences access the Web by using a wide range of devices (computer, PDA, cell phone, etc. . .) [8].
A thoughtful description of Web Services has been suggested (WIS) [8] in order to adapt web services to various users. Hence, the introduction of a notion of view and point of view to formalize the general need of the user and his profile on the basis of these two principles[8].
In this paper, we study a particular declination of the problem presented by R. BOUKOUR [8] (which is about the decomposition of web services into sub web services and collect them according to the characteristics and properties of each user known as point of view. This is to be finally displayed as a web service adapted to a given user called view [8]) .
We explore a solution using Relational concept analysis \ (RCA) and directed labeled graph for a better understanding by the software expert and we illustrate our proposal with a theoretical example.
Section 2 presents our example, then we describe the approach in Section 3. Related work is presented in Section 4, and then we conclude in Section5.

2. Illustration

This section presents the problem of a remodularization service-oriented architecture on an example. We will use the architecture extracted of the paper [8] shown in Figure 1 consists of a system house car sales [8] as a web service. It includes many basic sub web services that belong to different organizations: Car Purchase, Car Sale, the Credit Institution, Claim Service.... etc. The basic idea [8] was to decompose these web services into sub web services to meet the needs of each user and also to respond to the mutliview notion [8]. The house car manager has the right to add or remove a car brand or change the price. He has also the right to check the number of cars he sells, the number of cars remain in stock, cars that are being delivered and cars in the

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process of being ordered. He has also the right to change orders (add or cancel an order) [8]. The owner has the rights to deal with users complaints[8].
On the other hand, the customer has the right to see the car brands, their characteristics as well as the prices. He has also the right to check the availability of cars in stock and order a car or cancel an order that has already been made within a specific period. For some specific needs, a customer can file a claim[8].. Additionally, the user has other services that are not compulsory to the manager like the credit service for the funding of cars purchased by costumers[8].
Differentiation between the user and the manager will be made by a simple authentication. The latter will be illustrated by a web service. (Figure 1) shows a set of intervening parties in this example.

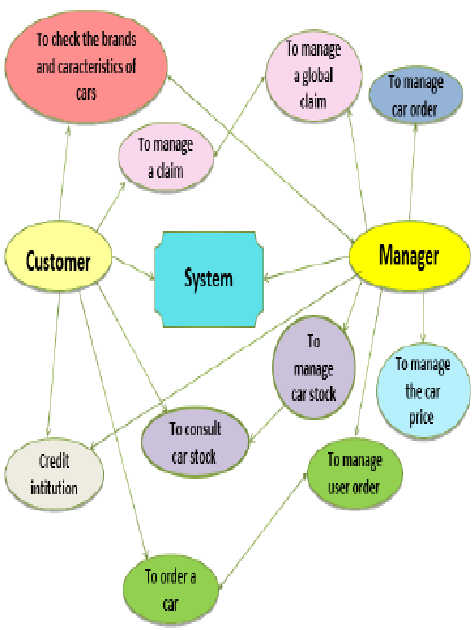

Figure 1. Interactions between customer and manager [8].

Table1 : Web services of the house car sales system[8].

Web service name	*Web service description*
WS1 : Car purchase service	Allows actors to buy a car. In our example the user can be either a client or a manager and they will be differentiated by the authentication and the profile of each one of them. The customer can buy a car from a manager and the same thing for the Manager, he can buy cars from individual or factories
WS2 : Car sale service	Is a service dedicated to the manager. It allows the sale of cars to customers in response to a request by the purchase service.
WS3 : Claim service	Allows the actors to manage the claims according to the norms imposed by the service. The claims will be used by the two profiles, the customer and the manager, each one of them see and use only the options that suit his needs
WS4 : The credit service	Is only seen by the customers that intend to buy cars. It allows the users to request the credits from the bodies accredited by the manager.
WS5 : Car price service	Allows the users to consult prices of cars, the customer can only consult the prices and compare them, the manager can consult and modify the car price.
WS6 : Cars stock service	Allows actors to access to car stocks. It is accessible after authentication to be adapted to profiles of each actor. A simple user can only consult the available stock. A manager in addition to consultation can also add cars.
WS7 : User profile service	Allows adapting the conversation depending on the user profile, in our case the profile is whether the customer or the manager.

Table 2 contains the sub web services obtained after decomposing sub web services according to the actors of our system[8].

Table 2: Sub Web services of the system house car sales[8].

Web Services	*Sub Web Services*
WS1	WS11: Consult a car to buy WS12: Buy a car
WS2	WS21: Sell a car WS22: Cancel a sale
WS3	WS31: Consult a claim WS32: File a claim WS33: Process a claim WS34: Delete a claim
WS4	WS41: Request a loan WS42: Consult a loan
WS5	WS51: Consult car price WS52: Add car price WS53: Modify car price WS54: Delete car price
WS6	WS61: Consult car stock WS62: Add car in the stock WS63: Modify car stock WS64: Delete car stock
WS7	WS71: Authentication for Manager, with administrator privileges WS72: Authentication for customer without administrator privilege

In table 3, we present the result of collecting Sub Web Services according to needs and access rights of the system users[8].
In this work , we are interested in the decomposition of web services into sub web services by using a Relational concept analysis *(RCA).*

3. Proposed approach

The Relational Concept Analysis (RCA[1]) is a technical relational data analysis whose objects are described by attributes and relations with other objects. The RCA is

Table 3: Sub web services used by each user [8].

USERS / *Web Services*	*MANAGER*	*CUSTOMER*
WS1	WS11	WS12
WS2	WS21, WS22	
WS3	WS31,WS33, WS34	WS32, WS31
WS4		WS41, WS42
WS5	WS51, WS52, WS53, WS54	WS51
WS6	WS61, WS62, WS63, WS64	WS61
WS7	WS71	WS72

[1]**http://www.lgi2p.ema.fr/~urtado/Slides/Huchard_partie1_14_02_2013.pdf** used in software engineering for solving several problems.

For remodularization of a service-oriented architecture, our exploration was carried following three steps.

Configurations In the context of our problem, we studied three different configurations.
We present all of them.

Step1: relational contexts : relation Object- Object

The first context is a relational context associates to each web service the sub services that comprise (see Figure 2, left panel).

Context (relational context C1).
- O1 is the set of Web services .
- A1 is the set of Sub Web services.
- R1 is the relation " is formed ".
- (e, p) ∈ R1 if e is formed of p, for example (ws1, ws11) ∈ R1.

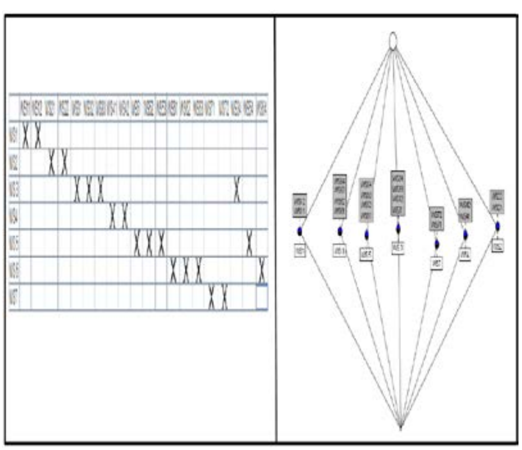

Figure 2. relational context C1 and lattice T(C1)

- Interactions between customer and manager -[8].

Step2: Object- attribute contexts

The second context is a formal context shows the sub web services used by each user (see Figure 3, left panel).

Context (formal context C2).
- O2 is the set of users.
- A2 : Sub web services used by each user.
- R2 is the relation " to use ".
- (e1, e2) ∈ R2 if R2 if e1 use e2, for example (Custumer, ws12) ∈ R2.

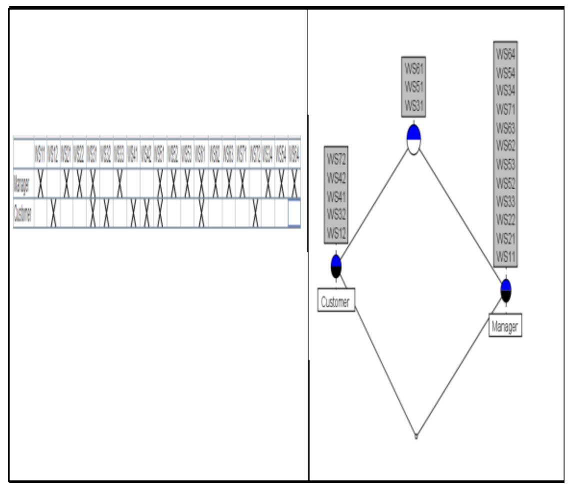

Figure 3. Formal context C2 and lattice T(C2)
- Interactions between customer and manager -[8].

Step3: we consider formal contexts enriched by the relational contexts

Context (formal contexts enriched by the relational contexts C3).
- O1 is the set of Sub Web services Web services used by each user .
- A1 is the set of Web services.
- R1 is the relation " is formed and used by".
- (e, (u,p)) ∈ R1 if e is formed of p and used by u , for example (ws1, ({Manager},{ws11})) ∈ R1.

The relational concept family with relation **:** Web service relative of sub services used (see figure5), allow us in an exploration for the decomposition of web services in sub services used by a Custumer or Manager .

3.1. Formalization of result of the obtained lattice

Example of exploration The exploration is to navigate through the lattice T (C3).
The lattice T (C3) identify **the** web service relative of sub services used by each user . It is showing the membership

of each sub Service used of the web service which concerning. We partially detail an example of analysis to explain the principle.

The lattice T (C3) allows to select following concept:

- Analysis of the concept ({WS2},{{Manager},{ WS21,WS22}}) the left of T (C3): Manager can use WS21 and WS22 sub services of the web service WS2 .

Figure 6 shows the Interactions between customer and manager result of remodularization .

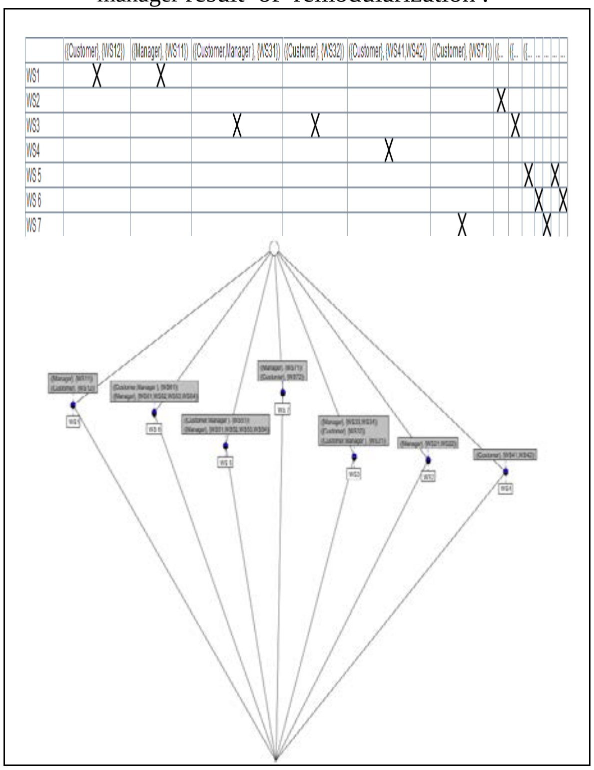

Figure 5. formal contexts enriched by the relational contexts C3 and the lattice T(C3).

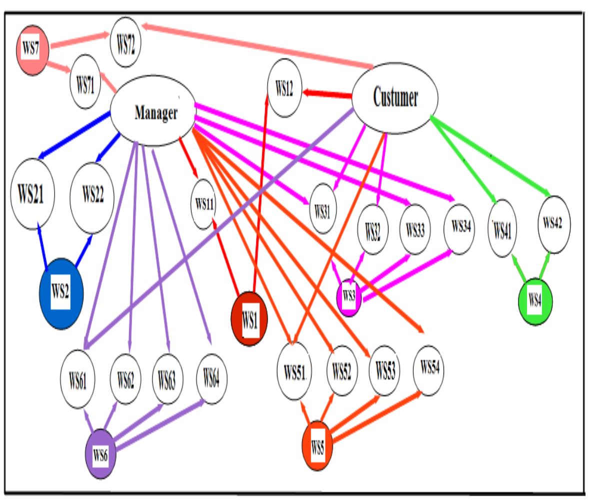

Figure 6. Interactions between customer and manager after remodularization .

The lattice of Figure 5 is used as follows:

- For all concepts this example ({WS2},{{Manager},{ WS21,WS22}}), objects and attributes are considered as nodes characterized by: WS2, Manager, WS21, WS22 .

- - The relationship between objects and attributes are represented by edges connecting each pair of nodes as an examplethe concept ({WS2},{{Manager},{ WS21,WS22}}) the left of T (C3): Manager can use WS21 and WS22 sub services of the web service WS2 where the nodes Manager and WS21 are connected by the edge (Manager, WS21) image of couple (**Attribute**, **Object**).

It is found that all the conditions are met to define a graph oriented, object of Figure 7 below from the result of the lattice of the figure 5.

Definition 1 (Oriented Graph) [9]:

A graph G is a mathematical structure defined by a pair (N, E) where N is a set of objects called nodes or vertices and E part of N * N which represents a set of arcs (also called edges) each connecting a pair of nodes. This general definition is a directed graph distinguishes two vertices s1 and s2 the edge (s1, s2) of the edge (s2, s1).

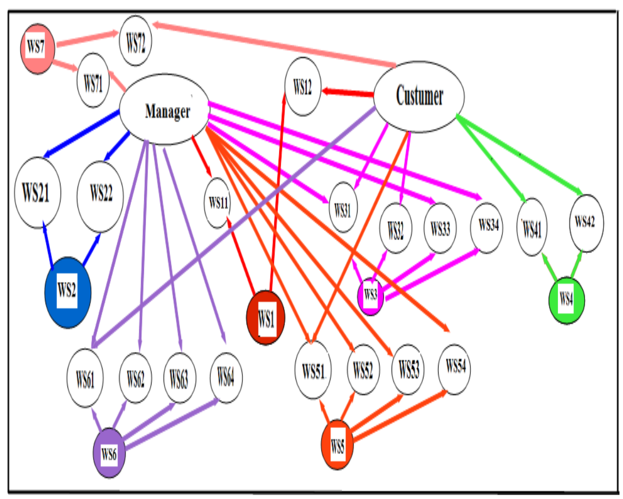

Figure 7. Oriented Graph result of the lattice of figure 5.

the original result of Figure 7 is in the form of directed graph and for a better understanding the result of remodularization its labeling is required.

We did call the labeled directed graph because it exists in the lattice relations "use" or " formed by ", object of Figure 8 applied to the following way:

- The labeled them "formed by" is used between two nodes of the same type whether of modules or requirements.
- The labeled "use" is used between two nodes of different types.

Our approach to labeling is inspired by part of the thesis Adil Anwar, Toulouse University [9] , treating Directed Labeled Graph and our last works [23] [24].

Definition 2 (Directed Labeled Graph) [9]:
Labeling of Graph G is a function l, or partial defined N ∪ E to a set of labels L (l: N ∪ E → L). For every element x in the field, the element l(x) is called the label of x.
The three types most common for labeling graphs are:
• The total labeling: in this case is the total function (defined on a set N ∪ E).
• The labeling of node: the domain of definition of l is N.
• The arc labeling: the domain of definition of l is E.
Typically, L is a set of integers but can also be a set of strings.
A labeled graph G is thus fully defined by the triplet (N, E, L) where N is an set of nodes, a set of edges E and l a function defined on labeling N ∪ E.

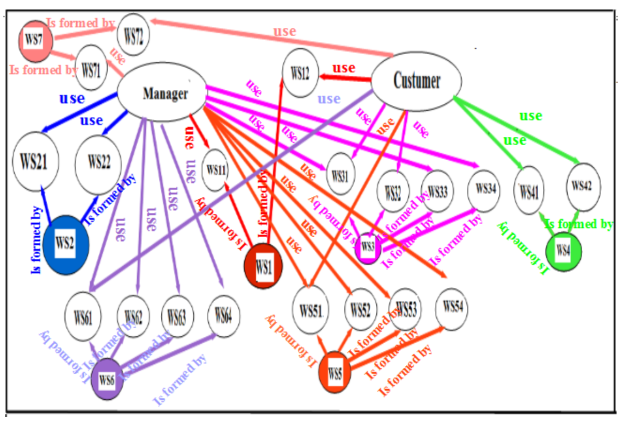

Figure 7. Directed Labeled Graph result of the lattice of figure 5 result of our remodularization.

4. Related Work

Different automated approaches have been proposed to restructure object systems. We cite three: the clustering algorithms, algorithms based on meta -heuristics and those based on the FCA[11]. The first aim to restructure system by the distribution of some elements (eg classes, methods , attributes) in groups such that the elements of a group are more similar to each other with elements of other groups [17] [18] [19]. Approaches to restructuring based on meta-heuristic algorithms [20] [21] are generally iterative stochastic algorithms, progressing towards a global optimum of a function by evaluating a certain objective function (eg characteristics or quality metrics). Finally, the approaches based on FCA [22] [12] provide an algebraic derivation of hierarchies of abstractions from all entities of a system. Reference [13] presents a general approach for the application of the FCA in the field of object-oriented software reengineering. In previous work, we added the dimension of exploration using the FCA[14] [15] [16].

We explored the issue of redistributing classes of a package to other packages. We used an approach based on Oriented Graph to determine the packages that receive the redistributed classes [4] .

Last work We use an approach based on relational concept analysis (RCA) to determine the packages that receive the redistributed classes[3].

An approach using the concept of view and the point of view of web services was adopted [5] [8].

In this paper , we present the usefulness of relational concept analysis for remodularization of a service-oriented architecture.

5. Conclusion

In this article we proceeded to the formalization of result obtained by remodularization at the level of web services [25] whose result has been a directed labeled graph for a better understanding by the software expert.

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