

Remodularization at the Level of Web Services by Using a Technique Based on Formal Concept Analysis (FCA)

Lala Madiha Hakik[†], Rachid El Harti^{††}

[†]*Faculty of Science and Techniques, University Hassan I, BP 577, Settat, Morocco.*

^{††}*Faculty of Science and Techniques, University Hassan I, BP 577, Settat, Morocco.*

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]. At this level an approach using the concept of view and the point of view of web services was adopted [5] [8]. This paper presents the usefulness of formal concept analysis for remodularization of a service-oriented architecture.

Keyword: Remodularization, Web Services, Formal Concept Analysis (FCA).

1. Introduction

Because of the inevitable evolution of software, their structure, which consists primarily of modular abstractions, more precisely in web services, erode more less slowly. Fighting against this erosion, including modernizing structure through 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, A. ETTALBI, M. NASSAR [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 formal concept analysis (FCA) and 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 Section 5.

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 multiview 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 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.

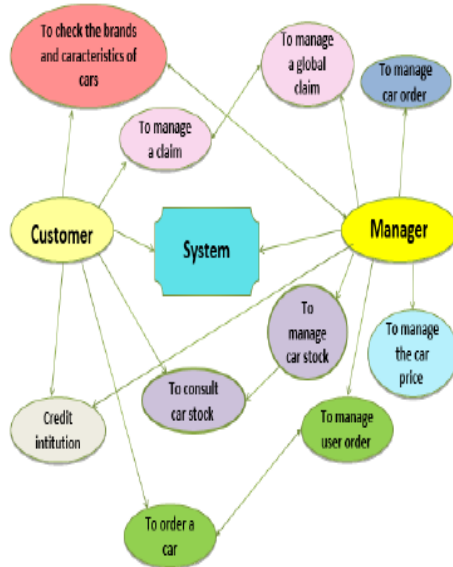


Figure 1. Interactions between customer and manager [8].

Table 1 : 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].

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

Web Services \ USERS	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

In this work , we are interested in the decomposition of web services into sub web services by using a formal method FCA.

3. Proposed approach

The Formal Concept Analysis (FCA) [11] [12] [13] [14] [15] [16] [17] is a technical data analysis that allows you to group entities with common characteristics. A concept is a maximal set of entities (extension of the concept) sharing a maximal set of characteristics (intension of the concept). The FCA is used in software engineering for solving several problems [12].

Configurations In the context of our problem, we studied one configuration with FCA.

The configuration with FCA is to define a formal context C: the set O of entities studied (or formal objects) Set A of characteristics (or formal attributes) and the relationship $R \subseteq O \times A$

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

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

Context (formal context C1).

- O1 is the set of Web services .
- A1 is the set of Sub Web services.
- R1 is the relation " is formed ".
- $(e, p) \in R1$ if e is formed of p, for example $(ws1, ws11) \in R1$.

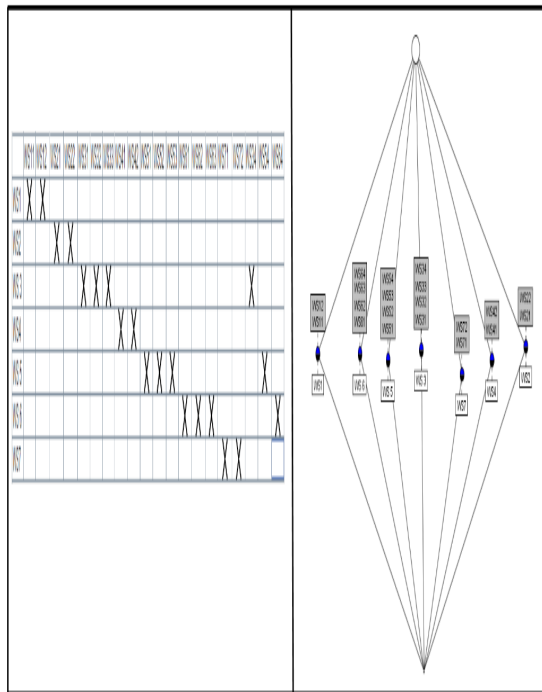


Figure 2. Formal context C1 and lattice T(C1)
- Interactions between customer and manager -[8].

The second 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 ".
- $(e1, e2) \in R2$ if e1 use e2, for example $(Customer, ws12) \in R2$.

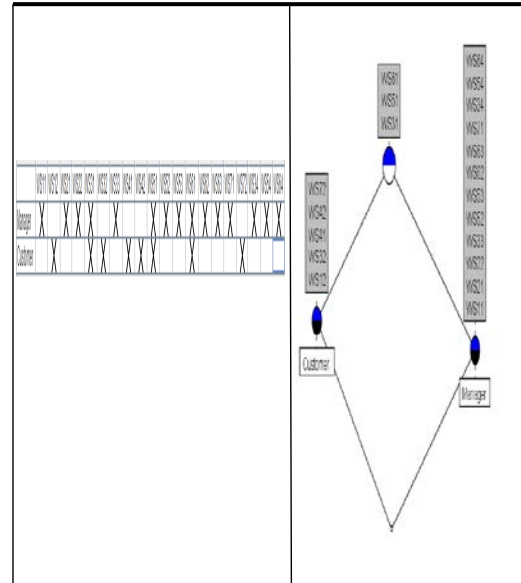


Figure 3. Formal context C2 and lattice T(C2)
- Interactions between customer and manager -[8].

Example of exploration The exploration is to navigate through two lattices T (C1) and T (C2).

The lattice T (C2) identify the sub web services used by each user and the lattice T (C1) which associates to each web service the sub services that comprise. It is showing the membership of each sub Service of the web service which concerning. We partially detail an example of analysis to explain the principle.

The lattices T (C1) and T (C2) can be divided into two blocks in which we will choose concepts.

1. Analysis of the concept $(\{Customer\}, \{WS12, WS32, WS41, WS42, WS71\})$ the right of T (C2): the Customer can use the sub services WS12, WS32, WS41, WS42, WS71, where browsing T (C1) we recognize their membership in the web service concerned,
2. Analysis of the concept $(\{WS1\}, \{WS11, WS12\})$ the left of T (C1) indicates that the sub service WS12 belongs the web service WS1, it is the same for other sub services.

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 formal concept analysis for remodularization of a service-oriented architecture.

6. Conclusion

In this article we explore the issue of the usefulness of formal concept analysis for remodularization of a service-oriented architecture.

This formal method occurred to formalize the result of work of the approach using the concept of view and the point of view of web services. [5] [8].

References

- [1] L.M. Hakik, R. El harti. Technique Of Redistribution Classes Of A Package With An Approach Based On Oriented Graph And Evaluation Quality of A Remodularized Software Architecture . International Journal of Innovative Research in Science, Engineering and Technology.ISSN:2319-8753. Vol. 3, Issue 1, January 2014.
- [2] L.M. Hakik, R. El Harti. Measuring Coupling and Cohesion to Evaluate the Quality of a Remodularized Software Architecture Result of an Approach Based on Formal Concept Analysis. IJCSNS International Journal of Computer Science and Network Security .Vol. 14 No. 1 pp. 11-16. Journal ISSN : 1738-7906. January 2014.
- [3] L. M. Hakik, R. El Harti. Application of the Relational Concept Analysis (RCA) for Remodularization of a Software Architecture and comparison with Others Techniques Based on FCA and Oriented Graph. IJCSNS International Journal of Computer Science and Network Security .Vol. 14 No.3. Journal ISSN : 1738-7906. March 2014.
- [4] L. M. Hakik, R. El Harti. Comparison of Results Obtained by Application of Techniques Based on Formal Concept Analysis and Oriented Graph for a Remodularisation Software Architecture Composed of Classes and Packages. . IJCSNS International Journal of Computer Science and Network Security .Vol. 14 No.2. pp. 11-16. Journal ISSN : 1738-7906. February 2014.
- [5] Haas, H., and Brown, A., Web Services Glossary, W3C Working Group Note, february2004.
- [6] L.M. Hakik, M. Huchard, R. El Harti et A.D. Seriai. Exploration de la redistribution des classes d'un package par des techniques d'Analyse Formelle de Concepts. The first conference in software engineering (CIEL 2012), France, 2012.
- [7] L.M. Hakik, R. El Harti . " *Exploring the Redistribution Classes of a Package with an Approach Based on Formal Concept Analysis* ", Vol.2 - Issue 12 (December - 2013), International Journal of Engineering Research & Technology (IJERT), ISSN: 2278-0181, www.ijert.org.
- [8] R. BOUKOUR, A. ETTALBI, M. NASSAR. Multiview Web Service: The Integration of The Notion of View And Point of View in The Web Services. IJCSNS International Journal of Computer Science and Network Security. Vol. 14 No. 2 pp. 31-36. Journal ISSN : 1738-7906.
- [9] Fauvet M. C., Models and Systems for Emerging Applications (continued) Chapter 6, Information Systems accessed via Web Services, November 14, 2005.
- [10] Melliti T., Interoperability of complex Web Services. Application to multi-agent systems, Ph.D. Thesis, university Paris IX Dauphine, 8 décembre 2004.
- [11] B. Ganter and R. Wille. Formal Concept Analysis. Mathematical Foundations. Spinge. 1999.
- [12] T. Tilley, R. Cole, P. Becker, P.W. Eklund. A survey of formal concept analysis support for software engineering activities. In Int. Conf. Fomal Concept Analysis (ICFCA 2005), pages 250-271, 2005
- [13] G. Arévalo, S. Ducass, and O. Nierstrasz. Lessons leaned in applying fomal concept analysis to reverse engineering. In Proceeding of the Third international conference on Fomal Concept Analysis, ICFCA'05, pages 95-112, Berlin. Heidelberg, 2005. Spinge-Velag.
- [14] L.M. Hakik, R. El Harti, " *Exploring the Redistribution Classes of a Package with an Approach Based on Formal Concept Analysis* ", Vol.2 - Issue 12 (December - 2013), International Journal of Engineering Research & Technology (IJERT), ISSN: 2278-0181, www.ijert.org.
- [15] Lala Madiha Hakik, Marianne Huchard, Rachid El Harti et Abdelhak Djamel Seriai. Exploration de la redistribution des classes d'un package par des techniques d'Analyse Formelle de Concepts. The first conference in software engineering (CIEL 2012), France, 2012.
- [16] Lala Madiha Hakik, Rachid El Harti . " *Technique of Adding A New Functionality in A Package with An Approach Based on Formal Concept Analysis* ", Vol.2 - Issue 12 (December - 2013), International Journal of Engineering Research & Technology (IJERT) , ISSN: 2278-0181 , www.ijert.org
- [17] B.S. Mitchell and S. Mancoridis. Compaing the decompositions produced by software clustering algorithms using similarity measurements. In ICSM, pages 744-753, 2001.
- [18] F.B. Abreu, G. Pereira, and P. Sousa. A coupling-guided cluster analysis approach to reengineer the modularity of object-oriented systems. In Proceeding of the confence on Software Maintenance and Reengineering. CSMR '00, pages 13-, Washington, DC, USA, 2000. IEEE Compter Society Press.

- [19] M. Bauer and M. Trifu. Architecture-aware adaptive clustering of oo s ystems. In Poceedings of the Eighth Euromicro Working Conference on Software Maintenance and Reengineering (CSMR '04), CSMR '04, pages 3-, Washington, DC, USA, 2004. IEEE Compter Society.
- [20] M.O'Keeffe and M. i Cinneide. Seach-based refactoring fo software maintenance. J. Syst. Softw., 81(4): 502-216, April 2008.
- [21] O. Seng, J. Stammel and D. Burkhart. Search- based determination of refactorings for improving the class structure of object-oriented systems, In Mike Cattolico, edito. GECCO, pages 1909-1916. ACM, 2006.
- [22] G.Snelting. Software reengineering based on concept lattices. In CSMR, pages 3-10, 2000.



Lala Madiha Hakik received the Maitrise in Computer Engineering, from Hassan 1st University, FST, Settati, Morocco in 2005, Specialized Master in Software Engineering, Montpellier -2- University, France in 2009, She is a PHD Student in Computer Science specialized in Software Engineering, University Hassan 1st, FST, Settati, Morocco, 2014.

Member of the specific scientific committee and editorial review on World Academy of Science, Engineering and Technology. Member of the international association of Engineers.



Rachid El Harti received the PHD in Mathematics and applications from Mohammed V University, Morocco in 1993, Full professor, Hassan 1st University, Morocco