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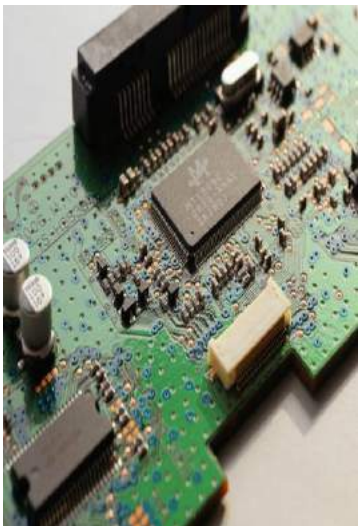


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Content

Validation of ATL Transformation to Generate a Reliable MVC2 Web Models

M'hamed RAHMOUNI
Department of Computer Science, Faculty of Science
Ibn Tofail University
Kenitra, BP 133, Morocco

Samir MBARKI
Department of Computer Science, Faculty of Science
Ibn Tofail University
Kenitra, BP 133, Morocco

***Abstract*—Technologies are constantly evolving. In order to benefit from technological advances, it is necessary to adapt the applications to these technologies. This operation is expensive for companies because it is often necessary to rewrite the code entirely. Where there is no capitalization of application functions and development is generally based on source code, the separation of concerns appears to be the necessary solution to the problem. Thus, functional specifications and technical specifications are taken into account separately by MDA approach. In this paper we present a new method of transformation validation and then we implement a new model transformation process based on MDA approach to generate an MVC2 Web model from Struts 2. This transformation begins by the validation of different transformation rules by applying the developed method of transformation validation.**

Keywords- MDA; Validation of transformation; Struts; ATL transformation; MVC2 architecture.

I. INTRODUCTION

The key requirement for development methodologies have always been motivated by the complexity and indeterminism of software engineering. In despite the multitude of approaches, very few achieve unanimity in the community. Most of them are adequate for a particular application field, and are generally based on a set of contextual beliefs and assumptions. In particular, object-oriented methodologies attempt to visualize, model and implement software as a set of interacting objects. The enthusiasm aroused by the object paradigm is such that dozens of methodologies have emerged since the nineties, making the choice of one method rather than another difficult. In response to this proliferation, in 2000, OMG launched the MDA approach, which is based on the concerns separation. It makes it possible to take into account, separately, the business aspect and the technical aspect of an application, thanks to the modeling. The application source code is obtained by automatic generation from the application models. Models are no longer just a visual or communication element, but are, in MDA approach [6]-[7], a productive element and a pivot of MDA process. In addition to MDA approach, companies are oriented towards using frameworks such as Struts2 [1], Hibernate [2] and Spring [3] [4].

The most methodologies of Web systems development [5], are as well based on model-driven engineering approach. Thus approaches of Web Engineering such as: WebML [8], OO-H [9], OOWS [10], UWE [11] and WebSA [12] propose to build different Web systems views following a horizontal concerns separation.

This work allows generates automatically an MVC2 web model that is a PSM model. This latter respects the architecture of MVC2 pattern. To arrive to this objective, we prepare PIM and PSM meta-models then we establish the different traceability links between these meta-models. After establishing the different traceability links, we applied our method of transformation validation which we will present in the next sections to ensure that our transformation rules are correct and valid. Then thereafter we define the different rules by ATL transformation language. Finally, we explain our method of transformation validation by applying these rules with a case study.

This paper is structured as follows: section 2 presents the process and methodology of this work. Section 3 explains MDA approach. Section 4 describes the validating method. Section 5 is devoted to the architecture of UML and Struts2 meta-models. Section 6 presents the transformation rules implementation. The transformation rules execution and the result of the execution process is the subject of section 7. Section 8 discusses the main related work, while section 9 wraps up the conclusions and future works.

II. PROCESS AND METHODOLOGY

In this work, the process starts by the presentation of a new method of transformation validation then the meta-modeling of Struts 2 framework allows implement the different CIM, PIM, and PSM meta-models. The CIM model of this work is an UML class diagram of a case study of an Employee management. The functional model (PIM) is a simplified UML meta-model. The PSM meta-model is a Struts2 meta-model. The PSM meta-model is presented in the figure 3. The next

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step is to define the ATL transformation rules and validation of these rules by the developed method. After this, we begin by the implementation of KM3 models corresponding to each meta-model then the different Ecore models corresponding to each KM3. The last step is to establish the traceability links between the components of source and target meta-models then, we define the different transformation rules in ATL transformation language. The result of this work is the MVC2 web model represented in EMF model. This is the configuration file of the proposed application. From the generated PSM model, we can generate the application code of the case study by applied an M2C transformation. The M2C transformation is neglected in this work. It will be the subject of future work.

The tools support of this work is the UML, ATL transformation language, MOF, XMI, KM3, OCL and EMF Project.

III. MDA (MODEL-DRIVEN ARCHITECTURE)

After procedural technology, object technology and component technology, the MDA [13] (Model-Driven Architecture) approach is a Model-Driven Engineering (MDE) process. MDA is proposed by the OMG (Object Management Group) in 2000. This approach is based on the separation of concerns. It allows take into account, separately, business aspect and technical aspect of an application, thanks to the modeling. The source code of application is obtained by automatic generation from application models. In MDA approach, the models are no longer just a visual or communication element, but are a productive element and a pivot of MDA process. To achieve a modeling or transformation process, MDA uses multiple standards such as UML [14], MOF [15], XMI [16], OCL [17] and many others.

This work is depicted to develop a validating method of transformation and the test of this method by a transformation example. In the following section, we present the theoretical and practical framework of new validation method.

IV. VALIDATING METHOD

Model transformations, especially the transformation rules specification constitute a major problem in context of model-driven engineering, which requires a great deal of precision, analysis and testing to arrive at the suitable transformations rules. In most cases of transformations, one falls into the ambiguity which obliges us to reconstruct our rules again, then to test if the code is the one we seek. Testing and rebuilding the rules is one of the time-wasting factors that all organizations are trying to minimize as much as possible. This operation constitutes a primordial phase in the case of transformations model. To solve this problem and ensure our rules before starting the transformation phase (translation of rules into code), as well as to keep the traces of these rules, we propose a new method of transformations validation, which will be called: MVT method, which is based essentially on a Petri Net and UML notations. In this paper, we present a new method of transformations validation. To explain this method we begin by a theoretical study as a principle of this method then the application of this method by using a case study example. The principle of this method is the subject of the following section.

A. The Method principle

In IDM context, a transformation corresponds to a T function between two modeling languages M and N [13]. The T transformation can be decomposed into two or more transformations t_1, t_2, t_3, ...,t_n such that T = $t_1.t_2$ ... t_n; "." Is the composition relation and T:: MMS→MMC (MMS: Source MetaModel and MMC: Target Metamodel).

The meta-classes of source and target meta-models are represented in this approach by the places of Petri Net whose name is the same name that refers to the place.

Each transformation rule is represented by a transition t_i. The composition relation between target metamodel elements and which results from t_i rule is represented by a C_{ij} transition. This later is an inner rule.

The T function represents the global transformation which makes it possible to obtain the target metamodel in its entirety from the source meta-model elements.

According to the method principle, we can conclude that: $T=\prod_{i=1}^{n}\left(t_i\bigcup_{j=1}^{m}C_{ij}\right)$ where t_i is a transformation rule number i, which makes it possible to transform an element of source metamodel to one or more elements of target metamodel. The C_{ij} relation is an inner transformation rule, transformation between elements of target metamodel, which means that a class is composed of a set of elements of another class. The compound element may be a resultant element of same transformation t_i or a resulting element of another transformation t_j. The first relation of composition will be called: simple composition noted C_{ii}. While the second relation of composition, it will be called: complex composition and it is noted C_{ij}.

If we put $t_k = t_i\bigcup_{j=1}^{m}C_{ij}$ and $T = \prod_{k=1}^{n}t_k$ then we get:

$T = t_1.t_2 \ldots\ldots\ldots .t_n$.

B. Application of Validation Method

Figure 1 shows the transformation rules validation, in accordance with the above cited method (Figure 1), we can ensure that these rules can generate all elements of target meta-model that they will need. There are the elements of target metamodel represented by the MVT method. This method is represented in the form of a flowchart which corresponds between the elements of source and target metamodel. This flowchart is represented in the following figure 1:

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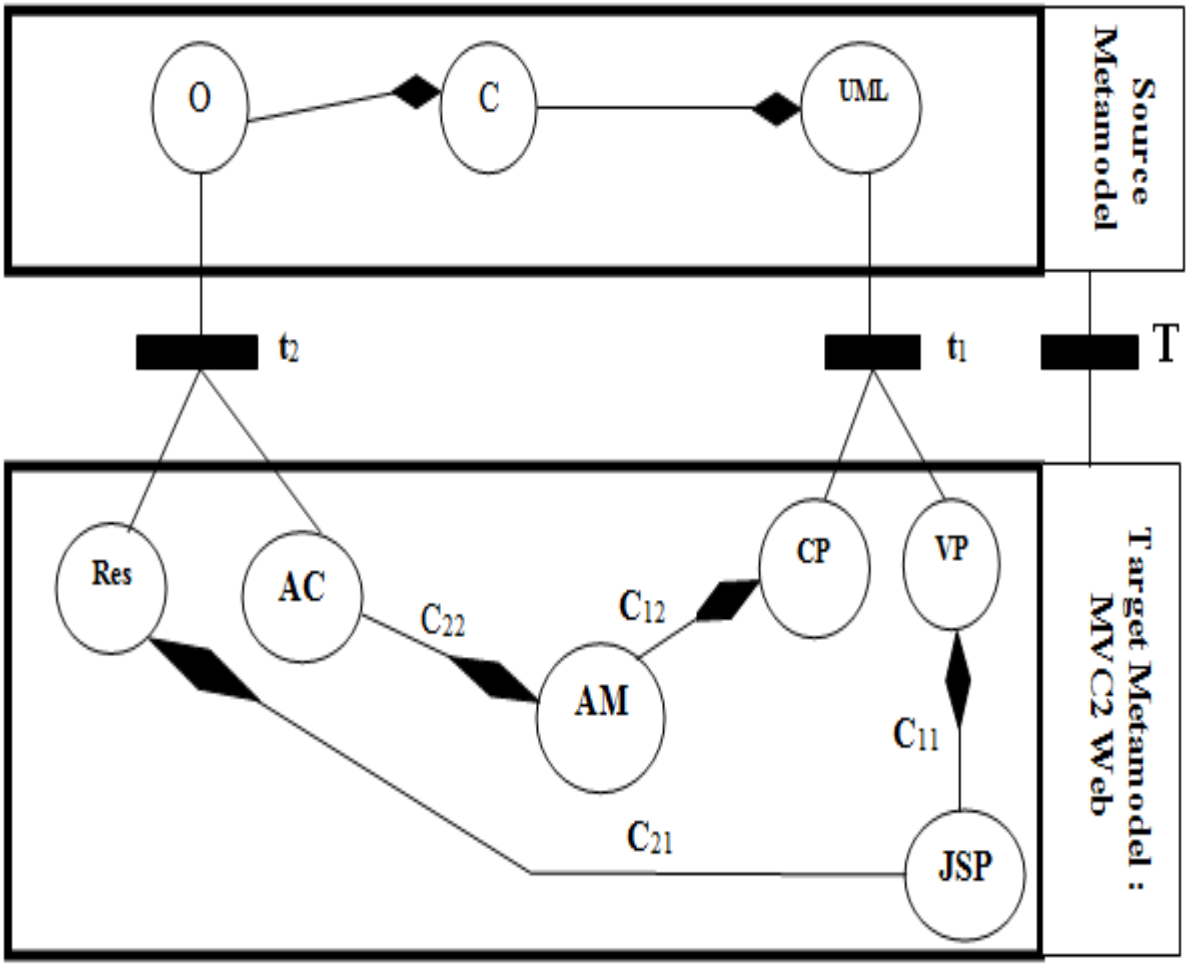

Figure 1. Representation of formation rules by flowchart of MVT method.

Table I. Elements abbreviation of source and target meta-model.

Elements of Source Metamodel	
UML	Package UML
C	Class
O	Operation
Elements of Target Metamodel	
VP	View Package
CP	Controller Package
AM	Action Mapper
JSP	JSP Page
AC	Action
Res	Result

To experiment this method, we conduct an ATL transformation based on MDA approach. In this transformation, we begin by establishing the different transformation rules between elements of source and target metamodel and thereafter we implement and define different rules by ATL language. In this transformation we begin by the definition of each element of source and target metamodel.

The source and target metamodel is the subject of the following section.

V. UML AND STRUTS META-MODELS

In this section, we present the various meta-classes forming the UML source and target meta-models.

A. *UML Source Meta-model*

The source meta-model structures the simplified UML model based on the package containing the data types and classes. Figure 2 presents the UML source meta-model. The different components of this meta-model are as follow:

- **UmlPackage:** Represents the concept of UML package. This meta-class is linked to the classifier meta-class.
- **Classify:** This is a generalization of meta-classes representing both the concept of UML classes and the concept of data type.
- **Class:** Represents the concept of UML classes.
- **DataType:** Represents the UML data types.
- **Operation:** Expresses the concept of methods of an UML class.

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- **Parameter:** Represents the concept of method parameters.
- **Property:** Expresses the concept of properties of an UML class.

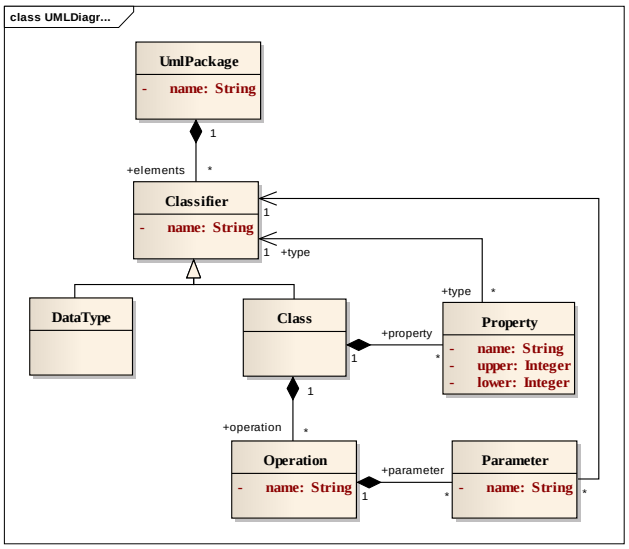

Figure 2. Simplified UML meta-model.

B. *Struts 2 Target Meta-model*

Figure 3 illustrates the target meta-model. This meta-model represents the concept of MVC2 web model. The Struts 2 meta-model is presented in first time in [36]. The different meta-classes of Struts 2 meta-model are as follows:

- **ModelPackage**: Expresses the UML package concept and designed the notion of Model in the MVC2 architecture.
- **ControllerPackage**: Indicates the controller concept in the MVC2 architecture.
- **ViewPackage**: Represents the concept of Views package .
- **ActionMapper**: Expresses the concept of ActionMapper class.
- **ActionProxy**: This is the concept of ActionProxy class.
- **ActionInvocation**: Indicates the concept of ActionInvocation class.
- **Action**: Represents the action concept in the controller package.
- **JspPages**: Indicates the concept of Jsp package.
- **Result**: Represents the concept of the generated result through an Action class.
- **The Interceptors**: This is an Interceptor package.
- **Interceptor**: Expresses the concept of interceptor classes.
- **HttpRequest**: Represents the concept of HttpServletRequest classes.
- **HttpResponse**: Expresses the HttpServletResponse classes concept.
- **Result**: Indicates the concept of Result classes.

VI. Transformation Rules Implementation

In this section we present the different steps from implementation to execution of different transformation rules. The first step is to implement the following meta-models: *N-tiers.km3*, *N-tiers.ecore*, *UML.km3*, *UML.ecore*. The second step is to establish the rules specification. After that, we define the different rules based on the specification rules. These rules are written in ATL language in a file named *UML2N-tiers.atl*. Finally, we prepare the source model. This model is an UML class diagram of Employee management. We translate the source model in XMI language.

To achieve this work, we have used different tools like: ATL plug-in integrated in Eclipse, OCL, XMI, UML, EMF project, KM3 and MOF.

In the following sections, we present the ATL transformation language then the rules specification and finally the implementation and execution of ATL transformation rules. The *km3* and *Ecore* meta-models cited above are not presented in this paper for letting it quite understandable and clear.

A. *ATL: Atlas Transformation Language*

ATLAS Transformation Language (ATL) is a model transformation language inspired by the OMG standard QVT. It developed in the framework of ATLAS project at LINA in Nantes [22]-[23]-[24]. ATL is part of Eclipse M2M (Model-to-Model) project [25]. Figure 4 shows the ATL operational framework.

B. *Rules Specification*

In this section, we present the main rules to transform an UML Class Diagram into an N-tiers Web model. The specification rules are as follow:

- The View package is composed of a set of JSP pages.
- Each UML package can generate a Struts2 package.
- The Struts 2 package is composed of a Struts package.
- The Struts package is composed of a Controller package and a View package.
- The Controller Package is composed of a set of Action classes.
- Each Action class is composed of a set of Result classes.
- Each Result is composed of a set of JSP pages.
- Each Operation can generate an Action and a JSP pages.

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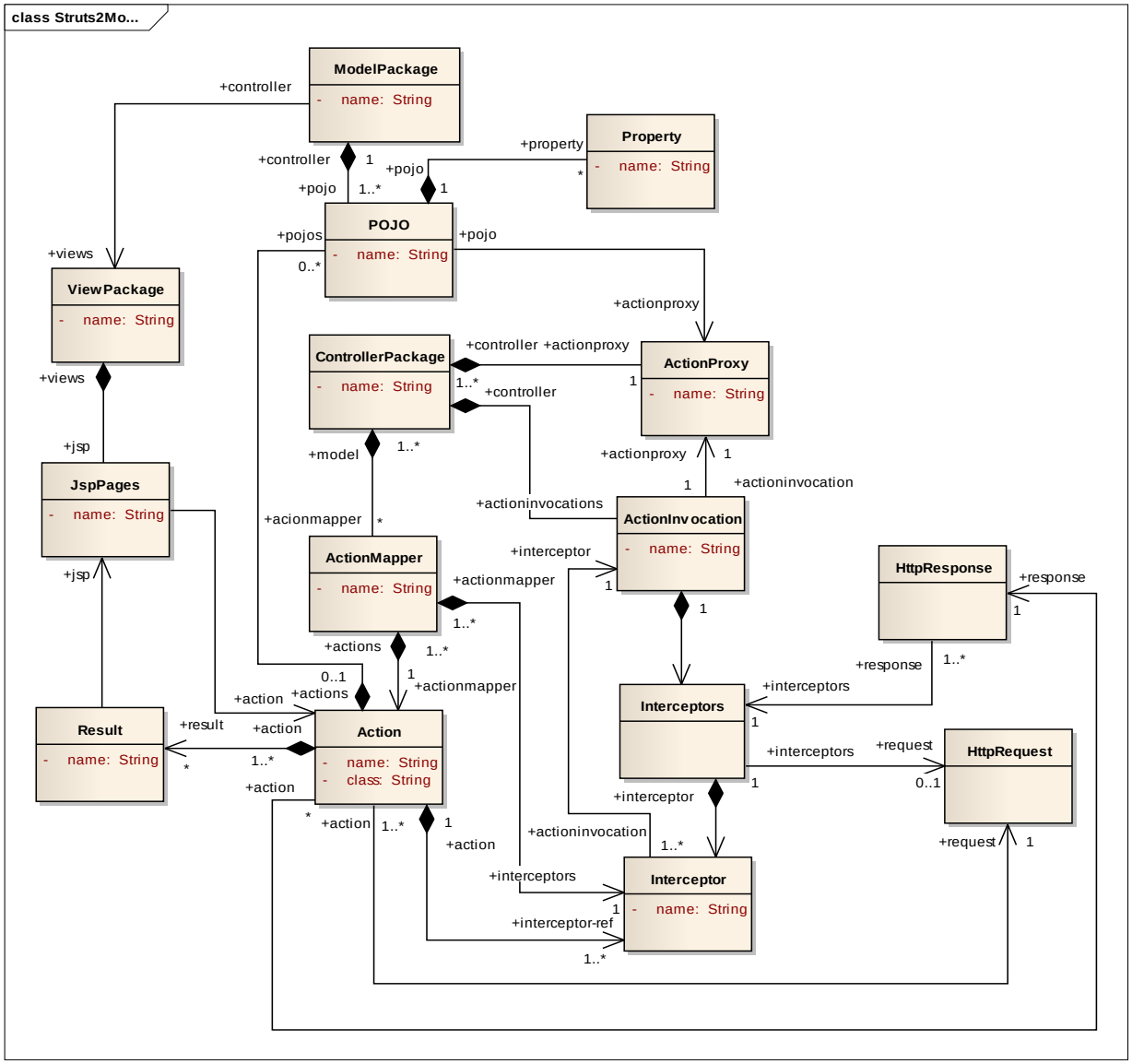

Figure 3. Struts2 Meta-model.

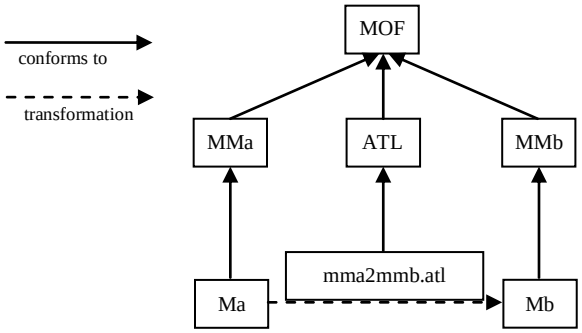

Figure 4. ATL Operational framework.

C. *Rules-Based transformation written in ATL*

In this section we present the different rules which transform the UML model into MVC2 web model. These rules are as follow:

Main Rule: From Operation to Struts 2 Action

This rule permits to generate the different action classes and jsp result of each Action. In this rule the name of jsp page is the name of the operation concatenated with the name of the class and followed by the extension ".jsp". This rule is composed of a three rules. These rules are as follow:

- Rule 1: From Operation to Action.
- Rule 2: From Operation to Result.
- Rule 3: Each Result is composed of a set of Jsp pages.

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The main rule is shown in figure 5. These rules are implemented by ATL language.

```
rule Operation2Action{

    from
        c : UML!Operation
    to
      js : NTiers!JspPage (
              name<- if c.name<>'Delete'then
                        c.name+c.class.name+'.jsp'
                     else 'Retrieve'+c.class.name+'.jsp'
                    endif
            ),
      frm : NTiers!Action(
            name<- c.name+c.class.name+'Action',
            method <- c.name+c.class.name,
            class <- 'com.web.struts2.'+c.name+c.class.name+'Action',
            result <- Sequence{fr}
          ),
      fr : NTiers!Result(
            name <- 'Success',
            type <- 'redirect',
            jsp <- js
        )
  }
```

Figure 5. Rule that generates Action classes and Jsp Pages

VII. Transformation Rules Execution

The execution algorithm of ATL transformation allows browsing all transformation rules and thereafter generates the MVC2 web model. This latter is represented in figure 7.

A. Case Study

In this case study, we consider a system of a three classes. This system can manage the employee of a given department. The system classes are: the City class, the Department class and the Employee class. In this system, we use only the CRUD (Create, Retrieve, Update, and Delete) operations. These are most often implemented in all systems. In this case we can generate the model which can manage the requested layer from the layers already defined. Figure 6 shows the UML class diagram of this system

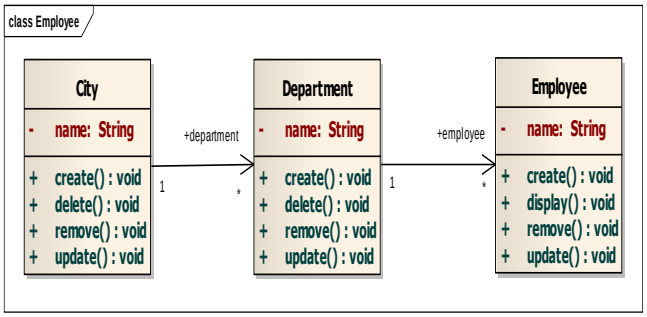

Figure 6. UML class diagram of the employee management system

B. ATL Transformation Result

The generated PSM model respects the web system architecture based on the patterns integration. Indeed, this model is composed of a set of Controller package, View package. The controller package is composed of a set of Action classes. The view package represents the different jsp pages.

Figure 7 shows the generated MVC2 Web model. This model contains the different ingredients for implementing a presentation layer respecting the architecture of MVC2 pattern.

In this section, we present a case study to demonstrate and exemplify our proposition. The UML class diagram of this case study represents the source model of our ATL transformation.

VIII. Related Work

In the last decade, several studies in model transformation and code generation have been conducted. The most relevant are: [26]-[11]-[27]-[28]-[29]-[30]-[31]-[32]-[33]-[34]-[36].

The work [26] allows generate JSP pages and JavaBeans by applying the UWE [11] combined with ATL transformation language [24]. The integration of AJAX into the UWE engineering process is considered as a future work of the authors.

The objective of the work [27] is to transform the PIMs models defined by Enterprise Distributed Object Computing into generated PSMs for different services platforms. The different transformation rules in this paper are defined by ATL language.

In [28], Billing et al. describes the different transformation rules permits to translate PIM to PSM in the EJB context. This transformation is realized by applying the approach by modeling based on QVT.

The work presented in [29] considers that MDA is a software industrialization pattern (or a software factory). The idea of this work is illustrated by a real case study in an IT services company. The main objective is to create MDA tools founded on XMI, XSLT and Visitor pattern. .It is a proposal to create MDA tools taking as base XMI, XSLT and the Visitor pattern.

The model-driven development approach for E-Learning platform is the subject of the work [30]. In this work the authors realize the CIM model by analyzing business logic. Then they establish the system diagram and the robustness analysis. Finally, the authors define a transformation method from PIM to PSM layer by layer.

The objective of the work [31] is to integrate a new framework for secure Data Warehouses design by applying MDA approach based on QVT.

The AndroMDA approach has earned attention in the community of web-based MDA [32]. This work allows transform a PIM schemes to model by integrating a wide variety of scenarios and comes with a set of plug-ins, called cartridge.

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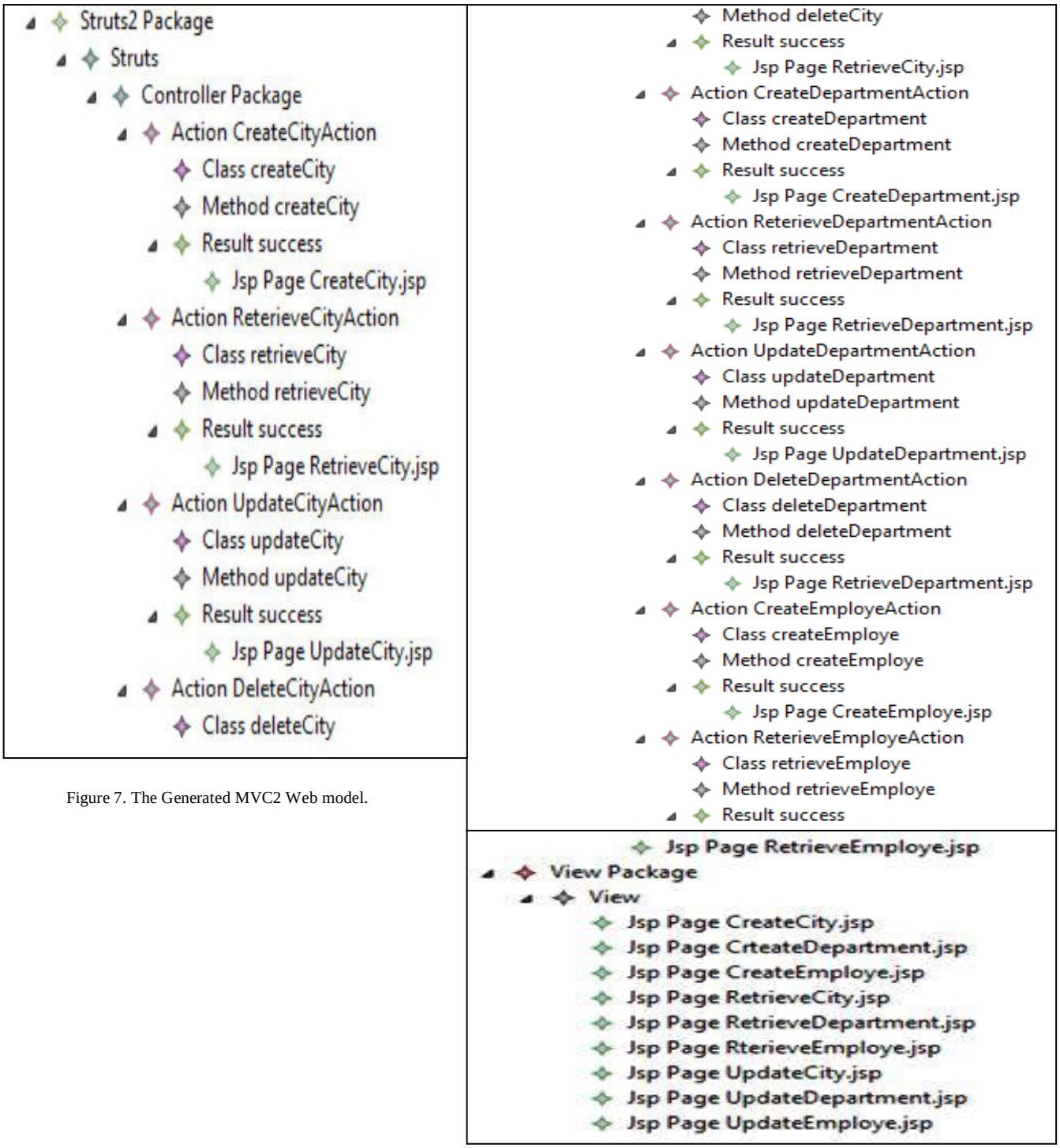

Figure 7. The Generated MVC2 Web model.

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In [33] the authors arrive to generate the MVC 2 web model from the Struts framework. They define the different transformation rules by ATL language in view to generate the CRUD operations from three classes Ci, Cj and Ck.

The work presented in [34] can generate the MVC 2 web model from the combination of the UML class diagram and the UML activity diagram. The main idea of this combination is to stabilize the UML class diagram and to determine the input jsp page of each Action class. In [35], the authors generate the MVC2 web applications code through the model already generated in [34] by using JET2 template integrated in Eclipse project.

The objective of the paper [36] is to generate the N-tiers web model from the integration of Struts2, Spring IoC and Hibernate DAO frameworks.

Finally, the objective of this paper is to validate the ATL transformation rules presented in this work which was not possible in [33]-[34]-[35]-[36]. This paper describes a new validation method of ATL transformation rules and the application this method.

IX. Conclusion and Future Work

The work presented in this paper is part of a context in which the size and complexity of software increases while the constraints of time, development and quality then the maintenance and evolution are always stronger. To respond to this trend, model engineering appears as a promising evolution of software engineering techniques. However, the success of a development approach is conditioned by the existence of techniques to ensure the quality of the product software. As we have shown in this paper, using models in a productive way requires well-formalized modeling environments and techniques to validate model transformation programs.

Our work is a step in the direction of reliable model engineering and open many perspectives in this field. In this case, we present a new method of transformation validation then we have applied the approach by modeling based on ATL transformation language to generate MVC2 web model from UML class diagram. This transformation is began by defining the traceability links between the UML source meta-model and MVC2 target meta-model already obtained. The algorithm execution of ATL transformations allow browsing all transformation rules and generate MVC2 PSM model respecting the architecture of MVC2 pattern. The generated MVC2 PSM model is an EMF model. This file can be used to produce automatically the necessary target application code. Finally, the transformation result was demonstrated and exemplified by a case study.

Furthermore, we plan to generate an e-business web code from the generated MVC2 web model by applying the model-to-code (M2C) transformations. In other hand, we can extend this method for considering other frameworks like: PHP, Zend and DotNet.

References

[1] Strsus2 homepage (2017). Retrieved February 4, 2017 from http: //www.struts.apache.org/2.x/.

[2] Hibernate homepage. Retrieved February 4, 2017 from http: //hibernate.org/.

[3] Spring homepage (2017). Retrieved February 2, 2017 from http: //projects.spring.io/spring-framework/.

[4] Arnaud Cogoluègnes, Thierry Templier, Julien Dubois , & Jean-Philippe Retaillé (2nd Ed.) . "Spring par la Pratique". 2009, Eyrolles.

[5] GertiKappel, Birgit Pröll, Siegfried Reich, & Werner Retschizegger. "Web Engineering". 2006, John Wiley.

[6] Blanc, X., "MDA en action : Ingénierie logicielle guidée par les modèles ". Eyrolles, 2005.

[7] Kleppe, A., Warmer, J., & Bast, W., "MDA Explained: The Model Driven Architecture: Practice and Promise". 2003, Addison-Wesley Professional.

[8] Stefano Ceri, Piero Fraternali, Aldo Bongio, Marco Brambilla, Sara Comai, & Maristella Matera. "Designing Data-Intensive Web Applications". 2003, Morgan Kaufman.

[9] Jaime Gómez, & Cristina Cachero. "OO-H: Extending UML to Model Web Interfaces". Information Modeling for Internet Applications. 2002. IGI Publishing.

[10] Pedro Valderas, Joan Fons, & Vicente Pelechano. "From Web Requirements to Navigational Design – A Transformational Approach". Proceedings of the 5th Int. Conference of Web Engineering (ICWE'05), 2005, LNCS 3579.

[11] Koch, N., "Transformations Techniques in the Model-Driven Development Process of UWE". Proceeding of the 2nd Workshopsh of Model-Driven Web Engineering (MDWE'06). 2006, Palo Alto.

[12] Santiago Meliá, & Jaime Gomez. "The WebSA Approach: Applying Model Driven Engineering to Web Applications". Journal of Web Engineering, Vol.5, No.2, 2006.

[13] Object Management Group (OMG). Model Driven Architecture. Document update/2012-06-27, Retrieved January 12, 2017 from http://www.omg.org/mda/.

[14] OMG. (2017, January). Unified Modeling Language. Available at : http://www.uml.org/

[15] Meta Object Facility (MOF), version 2.0, Retrieved January 20, 2017 from http://www.omg.org/spec/MOF/2.0/PDF/.

[16] XML Metadata Interchange (XMI), version 2.1.1. Retrieved January 28, 2017 from http://www.omg.org/spec/XMI/.

[17] Object Management Group (OMG) (2017). UML 2 Object Constraint Language (OCL). Retrieved January 30, 2017 from http://www.omg.org/cgibin/doc?ptc/2005-06-06.

[18] Pan Yuqing, & Wang Jiuli. "Design And Implementation of Accounting E-Business Platform for Source Documents". Proceeding in the International Conference on Computer Application and System Modeling (ICCASM 2010). 2010, DOI: 10.1109/ICCASM.2010.5622916.

[19] Spring AOP homepage. Retrieved January 8, 2017 from http://static.springsource.org/spring/docs/2.5.x/reference /aop.html.

[20] Praveen Gupta, & Govil, Prof. M.C., "Spring Web MVC Framework for rapid open source J2EE application development: a case study". International Journal of Engineering Science and Technology, Vol.2, No.6, 2010, pp.1684-1689.

[21] Praveen Gupta, & Govil, Prof. M.C., "MVC Design Pattern for the multi framework distributed applications using XML, spring and struts framework". International Journal on Computer Science and Engineering, Vol.2, No.4, 2010, pp.1047-1051.

[22] MENET, L., "Formalisation d'une Approche d'Ingénierie Dirigée par les Modèles Appliquée au Domaine de la Gestion des Données de Référence". PhD thesis, Université de Paris VIII, Laboratoire d'Informatique Avancée de Saint-Denis (LIASD), école doctorale : Cognition Langage Interaction (CLI), 2010

[23] Frédéric Jouault, & Ivan Kurtev, "Transforming Models with ATL". Proceeding in MoDELS 2005 Workshops, LNCS 3844, 2006, pp. 128 – 138, © Springer-Verlag Berlin Heidelberg.

[24] Jouault, F., Allilaire, F., Bézivin, J., & Kurtev, I., "ATL: A Model Transformation Tool". Sciences of Computer Programming-Elseiver, Vol.72, No.1-2, 2008, pp.31–39.

[25] AtlanMod (2017). Atl transformation language home page. Retrieved January 20, 2017 from http://www.eclipse.org/m2m/atl/.

[26] Kraus, A., Knapp, & A., Koch N., "Model-Driven Generation of Web Applications in UWE". Proceeding in the 3rd International Workshop on Model-Driven Web Engineering, CEUR-WS, Vol. 261, 2007.

[27] Bezivin, J., Hammoudi, S., Lopes, D., & Jouault, F., "Applying MDA approach for web service platform". Proceedings of the 8th IEEE International Entreprise Distributed Object Computing Conference (EDOC'04), 2004, pp.58-70.

[28] Bezivin, J., Busse, S., Leicher, A., & Suss, J.G., "Platform Independent Model Transformation Based on TRIPLE". In Middleware'04: Proceedings of the 5th ACM/IFIP/USENIX International Conference on Middleware, 2004, pp. 493- 51.

[29] Ndie, T. D., Tangha, C., & Ekwoge, F. E., "MDA (Model- Driven Architecture) as a Software Industrialization Pattern: An Approach for a Pragmatic Software Factories". Journal of Software Engineering & Applications, Vol.3, No.6, 2010, pp. 561-571.

[30] Cong, X., Zhang, H., Zhou, D., Lu, P., & Qin, L., "A Model- Driven Architecture Approach for Developing E-Learning Platform", Entertainment for Education. Proceeding of Digital Techniques and Systems Lecture Notes in Computer Science, Vol. 6249/2010, 2010, pp. 111-122, DOI: 10.1007/978-3-642-14533-9-12.

[31] Soler, E., Trujillo, J., Blanco, C., & Fernandez-Medina, E., "Designing Secure Data Warehouses by Using MDA and QVT". Journal of Universal Computer Science, Vol.15, No.8, 2009, pp.1607-1641.

[32] AndroMDA (2017). Retrieved January 15, 2017 from http: //www.andromda.org/.

[33] RAHMOUNI, M., & Mbarki, S., "MDA-Based ATL Transformation to Generate MVC 2 Web Models". International Journal of Computer Science & Information Technology (IJCSIT), Vol.3, No.4, 2011, pp. 57-70.

[34] RAHMOUNI, M., & Mbarki, S., "Combining UML Class and Activity Diagrams for MDA Generation of MVC 2 Web Applications". International Review in Computers and Software (IRECOS), Vol.8, No.4, 2013, pp.949-957.

[35] RAHMOUNI, M., & MBARKI, S., "An End-to-End Code Generation from UML Diagrams to MVC2 Web Applications". International Review in Computers and Software (IRECOS), Vol.8, No.9, 2013, pp.2123-2135.

[36] RAHMOUNI, M., & MBARKI, S., "MDA-Based Modeling and Transformation to Generate N-Tiers Web Model". Journal Of Software (JSW), Vol.10, No.3, 2015, pp. 222-238, DOI: 10.17706/jsw.10.3.222-238.

AUTHOR PROFILE

M'hamed RAHMOUNI received the Diploma of Higher Approfondie Studies in Computer Science and Telecommunication from the faculty of science, Ibn Tofail University, Morocco, 2007, and Doctorat of High Graduate Studies degrees in Computer Sciences from Ibn Tofail University, Morocco, January 10, 2015 . He participated in various international congresses in MDA (Model Driven Architecture) integrating new technologies XML, EJB, MVC, Web Services, etc. and he published many papers in the MDA domain.

Samir MBARKI received the B.S. degree in applied mathematics from Mohammed V University, Morocco, 1992, and Doctorat of High Graduate Studies degrees in Computer Sciences from Mohammed V University, Morocco, 1997. In 1995 he joined the faculty of science Ibn Tofail University, Morocco where he is currently a Professor in Department of computer science. His research interests include software engineering, model driven architecture, software metrics and software tests. He obtained an HDR in computer Science from Ibn Tofail University in 2010

An Extensible Web Mining Framework for Real Knowledge

N. Pushpalatha
Marri Laxman Reddy Institute of Technology & Management, Hyderabad, India

N. Subhash Chandra
Holy Mary Institute of Technology & Science
Hyderabad, India

***Abstract*—With the emergence of Web 2.0 applications that bestow rich user experience and convenience without time and geographical restrictions, web usage logs became a goldmine to researchers across the globe. User behavior analysis in different domains based on web logs has its utility for enterprises to have strategic decision making. Business growth of enterprises depends on customer-centric approaches that need to know the knowledge of customer behavior to succeed. The rationale behind this is that customers have alternatives and there is intense competition. Therefore business community needs business intelligence to have expert decisions besides focusing customer relationship management. Many researchers contributed towards this end. However, the need for a comprehensive framework that caters to the needs of businesses to ascertain real needs of web users. This paper presents a framework named eXtensible Web Usage Mining Framework (XWUMF) for discovering actionable knowledge from web log data. The framework employs a hybrid approach that exploits fuzzy clustering methods and methods for user behavior analysis. Moreover the framework is extensible as it can accommodate new algorithms for fuzzy clustering and user behavior analysis. We proposed an algorithm known as Sequential Web Usage Miner (SWUM) for efficient mining of web usage patterns from different datasets. We built a prototype application to validate our framework. Our empirical results revealed that the framework helps in discovering actionable knowledge.**

Keywords- Knowledge discovery; Web usage mining, Fuzzy clustering, Business intelligence.

I. INTRODUCTION

As enterprises in the real world need to know the web usage patterns of their customers, this research is useful to ascertain customer behavior and make strategies to improve customer satisfaction. The web usage mining for user behaviour analysis has many real world utilities. Building a framework that can cater to the needs of enterprises for user behaviour analysis is a challenging task. However, it is very useful to business community to make expert decisions. The user behaviour analysis needs different kinds of algorithms. In the proposed framework placeholders are provided for accommodating any kind of usage mining algorithms and fuzzy logic with combined processing. The fuzzy clustering can provide soft clusters that can be subjected to web usage mining for finding useful patterns. The patterns when interpreted by domain experts can result in business intelligence. Thus the proposed research has impact on the business community and consumer base as well. We used Wycombe District Council (WDC) dataset collected from Internet sources [1]. An excerpt of dataset is shown in Figure 1.

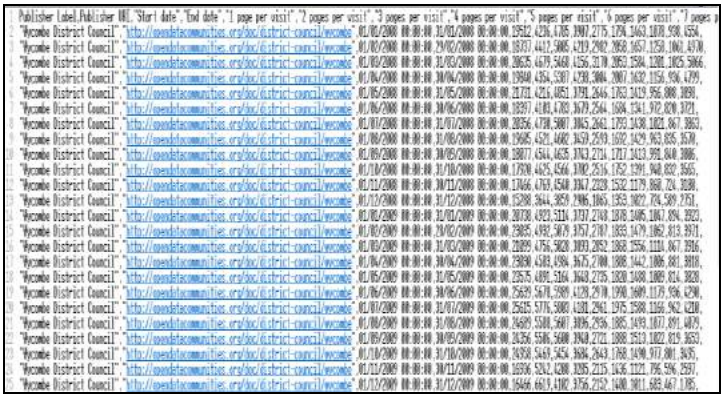

Figure 1. An excerpt from WDC dataset.

Different techniques came into existence in order to have user behavior analysis. However, we felt that a framework that can provide extensible features to have user behavior analysis is needed. In this paper we proposed and implemented a framework which is generic but provides placeholders for various future technologies. The framework is extensible and even supports personalized settings for user behavior analysis. The remainder of the paper is structured as follows. Section 2 provides review of literature. Section 3 presents the proposed framework. The section 4 presents experimental results while section 5 concludes the paper besides giving directions for future work.

II. RELATED WORK

Vythoulkas and Koutsopolous [16] employed neural networks, approximate reasoning, and fuzzy set theory for modelling choice behavior. They assumed that simple rules are used by decision makers. Rules and rule weights are used in the process of behavior analysis. Botha and Solms [17] used trend analysis and fuzzy logic for modeling behavior of intruders. Their approach is proactive based on the combination of trend

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analysis and fuzzy logic. Xia, Ho and Capretz [18] Neuro-Fuzzy logic for analyzing software usage trends in the industry. Anderson et al. [19] focused on the analysis of user behavior with respect to fall in human life. Fuzzy logic and voxel person are used to detect fall behavior of humans using pre-recorded videos. Wang et al. [20] employed neural networks and fuzzy logic for behavior of attackers with respect to intrusions. They used KDD CUP 1999 dataset for analyzing behavior of intruders. Mitrovic et al. [21] explored behavior of bloggers with quantitative analysis. They focused on the behavior that is reflected by emotions. They combined machine learning and statistical physics to analyze emotional behavior of web users.

Adadeh, Mohamadi, and Habibi [22] used genetic fuzzy systems for analyzing malicious users. They employed iterative rule learning to have knowhow on the user behavior. A good survey of fuzzy web mining can be found in [23] where techniques pertaining to fuzzy web structure mining, fuzzy web content mining and fuzzy web usage mining. Velesquez [24] combined both web usage mining and eye-tracking technologies for classifying web site key objects. This has provided more effective means of mining pertaining to web usage. He [25] focused on case based reasoning (CBR) and text mining for understanding user experience and improves it. They observed that text mining and Web 2.0 usage can bring about more useful information towards user behavior. Cruz-Benito et al. [26] explored educational virtual world for user behavior. They discovered usage behavior of users in the education domain in the learning process. Conti et al. [27] studied user behavior pertaining Android application usage. They focused on user actions and the trends in the user behavior in using Android applications. Vu et al. [28] focused on travel behavior of tourists. They used the notion of geotagging photos for user behavior analysis. Abello et al. [29] made a survey of semantic web technologies used for Online Analytical Processing (OLAP) which can be used for user behavior analysis.

The different approaches employed in the literature are good for specific purposes. However, we found that there is a need for a comprehensive framework with flexible and extensible technologies that can cope with future technologies as well. In this paper we proposed and implemented a framework which is generic but provides placeholders for various future technologies. The framework is extensible and even supports personalized settings for user behavior analysis.

III. Proposed Framework

We proposed a framework which is generic in nature and accommodates future technologies in order to have better performance in user behavior analysis which helps in finding knowhow on web usage. The framework is named as eXtensible Web Usage Mining Framework (XWUMF). The framework provides reusable components or building blocks that can be used along with customized logic. The framework supports a hybrid approach which can have fuzzy clustering techniques and web mining techniques working together to have effective user behavior analysis mechanism. Memory usage and time taken are the two performance evaluation parameters it supports for every operation in the framework. The framework accommodates new pre-processing techniques, fuzzy clustering techniques and web mining techniques so as to make the proposed framework flexible and extensible. Before presenting our framework, the overview of general web usage mining is shown in Figure 2.

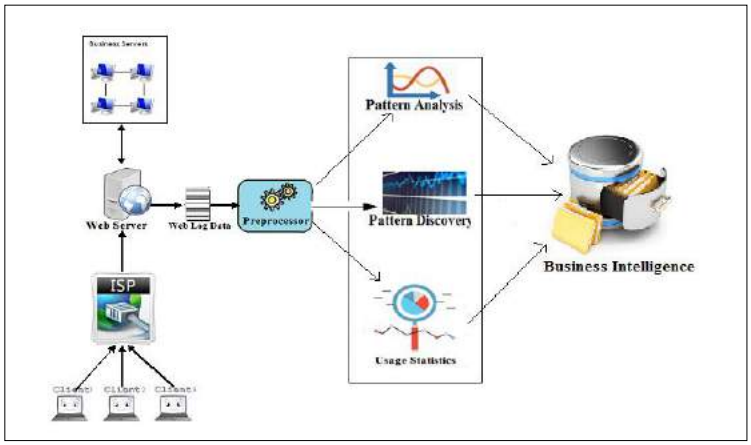

Figure 2. General Web Usage Mining Overview.

Web log data collected from web servers is subjected to pre-processing and then user behavior analysis in order to obtain business intelligence. In this approach the web log data comes from different sources. The data is pre-processed to improve the data by handing missing values. Then the data is subjected to usage mining, pattern discovery and pattern analysis. Finally the method results in business intelligence. The BI is in the form of well-structured patterns that have been interpreted by domain expert.

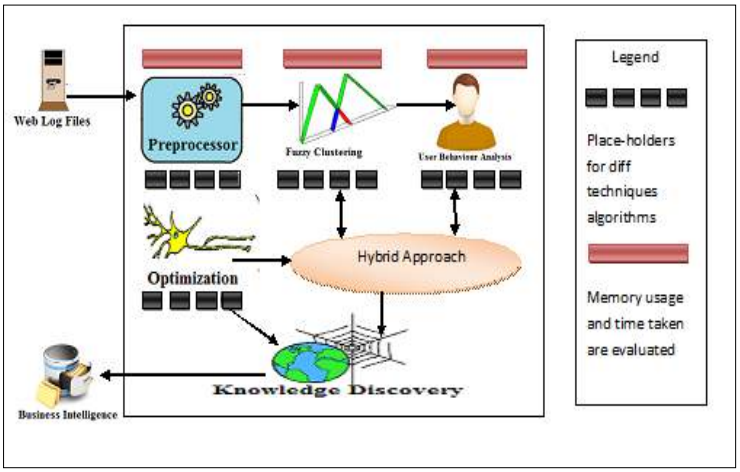

Figure 3. Proposed framework named **XWUMF**.

As shown in Figure 2, the web log files collected from various sources are subjected to pre-processing. It is similar to that of first method. After pre-processing, the framework supports a hybrid approach which combines fuzzy clustering and user behavior analysis. The framework has placeholders for pre-processing techniques, fuzzy clustering techniques, user behavior analysis and optimization. The framework is flexible and helps developers to build new techniques by referring to existing ones. The framework reflects that fact that future enhancements to the proposed framework are accommodated.

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The flexible and generic framework can be realized with web mining as solution for extracting business intelligence from various sources of data. The measures considered for evaluating the proposed work are memory usage an time taken to perform various operations. Our empirical study in this paper is limited to web mining technique only. The full implementation details are presented in our next research paper. The algorithm we implemented as part of the framework is shown here.

Algorithm: Sequential Web Usage Miner
Inputs : Sequence Web Log Data, ***mintime***, ***minconf***
Output : User Behavior in terms of Usage Patterns

```
Initialize usage time vector UT
Initialize web log data vector WLD
Initialize rules vector R
Initialize final rules vector R'
Load sequence web log data into to WLD
Compute Usage Time
For each row in WLD
  Compute usage time ut
  Add ut to UT
  Associate UT with WLD
End For
Prune Search Space
For each row in WLD
  IF ut >= mintime THEN
    Remove row from WLD
  END IF
End For
Compute Rules from WLD
Compute rules into R
Validate Rules
For each r in R
  Compute conf_WLD(r)
  IF conf_WLD(r) >= minconf THEN
    Add r to R'
  END IF
End For
Output R'
```

Algorithm 1. Sequential web usage miner

The algorithm is named Sequential Web Usage Miner (SWUM) which takes sequence web log data, minimum time, and minimum confidence as inputs. It generates patterns that reflect user behavior. First of all usage time of the web pages is computed based on the data provided in the dataset. For instance usage time of users for different web pages is shown in Fig. 1. The usage time is considered to filter out processing by using MinTime parameter. The minimum confidence provides further statistical measure to have quality patterns. The search space is pruned using MinTime and minimum confidence parameters. This process can improve the performance of algorithm for user behavior analysis. Then rules are computed from the web log data. The rules reflect the trends in web usage. Then the rules are validated to have final results in the form of web usage trends.

IV. Experimental Results

We made experiments in a PC with i7 processor running Windows 10 operating system. We built a prototype application using Java platform. Java IO package is used to work with dynamics of datasets. Java Swing Application Programming Interface (API) is used for managing Graphical User Interface (GUI). We used Java Collections API for storing data and performing web usage mining. We used the proposed algorithm for mining user behavior in terms of usage patterns. Four datasets are used for experiments. The first dataset is known as Wycombe District Council (WDC) which is collected from [1]. The other three datasets are synthesized datasets to have better evaluation of the proposed algorithm. The important observations are the web usage patterns obtained from the dataset besides the performance measures like execution time and memory usage. Execution time is the measure used to know how fast the proposed algorithm is working while the memory usage is another performance measure used to know how much main memory is needed to process the data for user behavior analysis.

A. Results with MinTime between 5000 and 20000

We made experiments with all the four datasets using minimum time usages between 5000 and 20000 seconds. In fact minimum time is the support kind of statistical measure in data mining used to obtain quality results. Table 1 shows the execution times for different datasets observed while performing user behavior analysis.

Min Time	Execution Time (Sec)			
	WDC	Dataset 2	Dataset 3	Dataset 4
5000	0.220	2.828	6.409	14.084
10000	0.193	2.351	5.043	12.295
15000	0.196	2.508	5.354	13.685
20000	0.223	3.520	6.241	13.098

Table 1. Execution time (s) for different datasets

The execution time is more when MinTime parameter is increased. The rational behind this is the time taken for filtering out tuples in the dataset. There is gradual increase in time taken when MinTime parameter value is increased. . In case of the fourth dataset the execution time is 14.08 seconds and 12.29 seconds for MinTime 5000, 10000 similarly the execution time is 13.68 seconds and 13.09 seconds for Dataset four when MinTime is 15000 and 20000. The visualization of the results is shown in Figure 3.

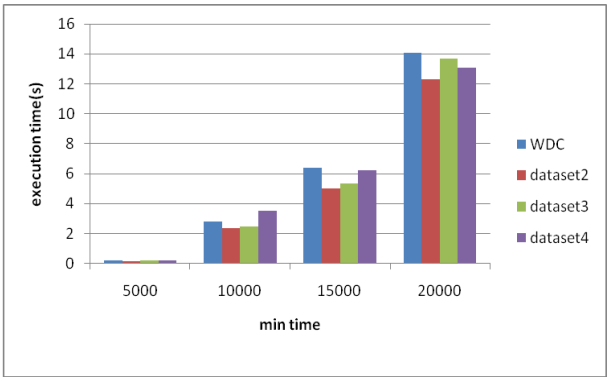

Figure 4. Shows execution time for different datasets when MinTime parameter range is between 5000 and 20000.

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The MinTime parameter has its influence on the time taken for user behavior analysis. At the same time there is difference in time taken for different datasets due to the size of datasets.

B. Results with MinTime between 25000 and 40000

Min Time	Execution Time (Sec)			
	WDC	Dataset 2	Dataset 3	Dataset 4
25000	0.218	2.724	5.562	13.609
30000	0.312	3.126	5.425	13.882
35000	0.199	3.113	7.428	12.191
40000	0.143	2.559	5.781	14.513

Table 2. Execution time for different datasets when MinTime parameter range is between 25000 and 40000

This experiment is made with different MinTime range that is between 25000 and 40000. WDC shows gradual increase in time taken when MinTime increases. In case of the fourth dataset the execution time is 13.6 and 13.8 seconds for MinTime 25000, 30000 similarly the execution time is 12.2 and 14.5 seconds for Dataset four when MinTime is 35000 and 40000.

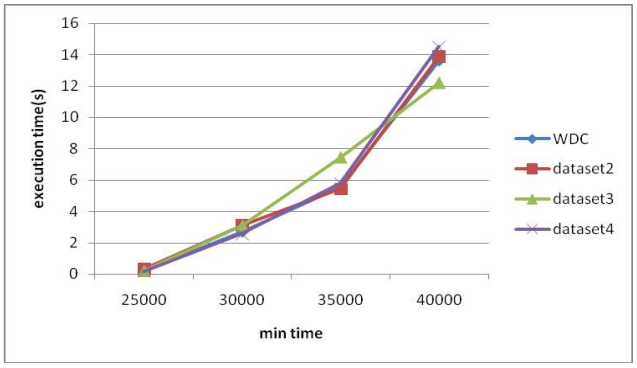

Figure 5. Execution times taken for user behavior analysis for different datasets with MinTime parameter range between 25000 and 40000.

As shown in Fig. 4, it is evident that there is increasing trend with all datasets in execution time with some exceptions. With MinTime 20000, the datasets showed increasing execution time from WDC to Dataset 4. Here the WDC also shows increasing execution time as MinTime increases with exception for Mintime 14000.

MinTime	Memory (MB)			
	WDC	Dataset 2	Dataset 3	Dataset 4
5000	5.947838	119.8514	184.6231	335.3677
10000	5.98597	121.2761	177.7986	320.0214
15000	5.928062	107.6817	183.1708	330.2894
20000	5.928093	116.6732	182.8204	303.5607

Table 3. Memory Usage performance of user behavior analysis for different datasets with MinTime parameter range between 5000 and 20000.

As shown in Table 3, the proposed algorithm needed 5.94 MB of main memory for user behavior analysis using WDC dataset. The three synthetic datasets show almost similar memory usage with slight difference. The maximum memory is consumed by the algorithm to process Dataset 4 while minimum memory is consumed by the algorithm for WDC dataset.

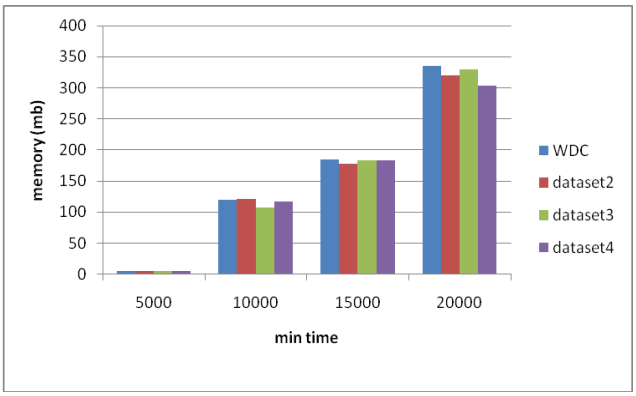

Figure 6. Memory Usage taken for user behavior analysis for different datasets with MinTime parameter range between 5000 and 20000.

As shown in Fig. 5, the memory usage dynamics are presented. WDC needed less main memory when compared with other datasets. The proposed algorithm makes use of main memory for user behavior analysis.

MinTime	Memory (MB)			
	WDC	Dataset 2	Dataset 3	Dataset 4
25000	5.920708	109.8285	190.4586	329.9598
30000	5.90757	116.37	186.1025	320.612
35000	5.923828	120.343	181.3618	306.5138
40000	5.9076	117.943	182.3883	334.3728

Table 4. Memory Usage performance of user behavior analysis for different datasets with MinTime parameter range between 25000 and 30000

As shown in Table 4, the proposed algorithm needed 5.92 MB of main memory for user behavior analysis using WDC dataset. The three synthetic datasets show almost similar memory usage with slight difference. The maximum memory is consumed by the algorithm to process Dataset 4 while minimum memory is consumed by the algorithm for WDC dataset.

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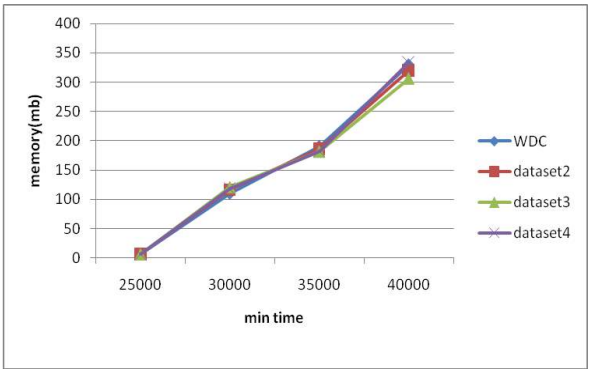

Figure 7. Memory Usage taken of user behavior analysis for different datasets with MinTime parameter range between 25000 and 30000.

As shown in Fig. 6, the memory usage dynamics are presented. WDC needed less main memory when compared with other datasets. The proposed algorithm makes use of main memory for user behavior analysis.

V. Conclusions And Future Work

In this paper we studied the problem of web usage mining. We proposed a framework named eXtensible Web Usage Mining Framework (XWUMF). The framework supports hybrid approach for processing web log data. Web log data provides usage behavior of customers. User behavior analysis is made using the combination of web mining and fuzzy logic. The proposed framework is flexible and extensible so as to support different combination of techniques in future. User behavior analysis can be made using the proposed algorithm in different domains. The framework is not tied with any kind of domain. Customer-centric approach can be leveraged by enterprises by using the framework for user behavior analysis. The business intelligence in this regard is essential as there is intense competition among business in the real world. In this paper we implemented web usage mining algorithm named Sequential Web Usage Miner (SWUM) for efficient mining of web usage patterns from different datasets. We used four datasets for validating efficiency of the proposed algorithm. We built a prototype application to validate our framework. Our empirical results revealed that the framework helps in discovering actionable knowledge. We implement the rest of the framework in our future work for having accurate results in web usage mining.

References

[1] K. R. Suneetha and Dr. R. Krishnamoorthi. (2009). Identifying User Behavior by Analyzing Web Server Access Log File. IJCSNS. 9 (4), p.1-6.

[2] Eugene Agichtein, Eric Brill and Susan Dumais. (2006). Improving Web Search Ranking by Incorporating User Behavior Information. ACM. p.1-8.

[3] Gerd Stummea, Andreas Hotho a, Bettina Berendt b. (2006). Semantic Web Mining State of the art and future directions. ELSEVIER. p1-20.

[4] Osmar R. Zaiane and Jun Luo. (2001). Towards Evaluating Learners' Behaviour in a Web-Based Distance Learning Environment. IEEE. p1-5.

[5] MAGDALINI EIRINAKI and MICHALIS VAZIRGIANNIS. (2003). Web Mining for Web Personalization. ACM. 3 (1), p1-27.

[6] Doru Tanasa and Brigitte Trousse. (2004). Advanced Data Preprocessing for Intersites Web Usage Mining. IEEE. p1-7.

[7] Crist´obal Romero. (2010). Educational Data Mining: A Review of the State of the Art. IEEE. 40 (6), p1-20.

[8] Raymond Kosala and Hendrik Blockeel. (2000). Mining Research: A Survey.SIGKDD. 2 (1), p1-15.

[9] Ricardo Baeza-Yates, Carlos Hurtado, Marcelo Mendoza and Georges Dupret . (2005). Modeling User Search Behavior. IEEE. p1-10.

[10] Ed H. Chi, Peter Pirolli, Kim Chen, James Pitkow. (2001). Using Information Scent to Model User Information Needs and Actions on the Web. ACM. p1-8.

[11] Vincent S. Tseng, Kawuu W. Lin. (2006). Efficient mining and prediction of user behavior patterns in mobile web systems. ELSEVIER. p1-13.

[12] Nathan Eagle Æ Alex (Sandy) Pentland. (2005). Reality mining: sensing complex social systems. Springer. p1-14.

[13] Olfa Nasraoui, Esin Saka and Antonio Badia. (2008). A Web Usage Mining Framework for Mining Evolving User Profiles in Dynamic Web Sites. IEEE. 20 (2), p1-14.

[14] Raghu Krishnapuram, Anupam Joshi, Olfa Nasraoui and Liyu Yi. (2001). Low-Complexity Fuzzy Relational Clustering Algorithms for Web Mining.IEEE. 9 (4), p1-13.

[15] Yunjuan Xie and Vir V. Phoha. (2001). Web User Clustering from Access Log Using Belief Function. ACM. p1-7.

[16] Petros C. Vythoulkas and Haris N. Koutsoulos . (2003). Modeling discrete choice behavior using concepts from fuzzy set theory, approximate reasoning and neural networks. elsevier. (n.d), p51-53.

[17] Martin Botha and Rossouw von Solms. (2003). Utilising fuzzy logic and trend analysis for effective intrusion detection. elsevier. (n.d), p423-434.

[18] Wei Xia, Danny Ho and Luiz Fernando Capretz. (2008). A Neuro-Fuzzy Model for Function Point Calibration. 5 (n.d), p22-30.

[19] Derek Anderson , Robert H. Luke , James M. Keller , Marjorie Skubic , Marilyn Rantz and Myra Aud . (2009). Linguistic summarization of video for fall detection using voxel person and fuzzy logic. elsevier. (n.d), p80-89.

[20] Gang Wang ,Jinxing Hao , Jian Mab, Lihua Huang . (2010). A new approach to intrusion detection using Artificial Neural Networks and fuzzy clustering. elsevier. (n.d), 6225–6232.

[21] Marija Mitrovi, Georgios Paltoglou and Bosiljka Tadi. (2011). Quantitative analysis of bloggers' collective behavior powered by emotions. josmte. (n.d), p1-17.

[22] Mohammad Saniee Abadeh , Hamid Mohamadi and Jafar Habibi. (2011). Design and analysis of genetic fuzzy systems for intrusion detection in computer networks. Elsevier, p7067–7075.

[23] Chun-Wei Lin and Tzung-Pei Hong. (2013). A survey of fuzzy web mining. WIREs Data Mining and Knowledge Discovery. 3 (n.d), p190–199.

[24] Juan D. and Velasquez . (2013). Combining eye-trackingtechnologieswithwebusageminingforidentifying Website Keyobjects. elsevier. (n.d), p1-10.

[25] Wu He, Improving user experience with case-based reasoning systems using text mining and Web 2.0. elsevier. 40 (n.d), 500–507, 2013.

[26] Juan Cruz-Benito , Roberto Therón , Francisco J. García-Peñalvo and Emiliana Pizarro Lucas. (2014). Discovering usage behaviors and engagement in an Educational Virtual World. elsevier. (n.d), p1-8.

[27] Mauro Conti,Luigi V. Mancini and Riccardo Spolaor. (2015). Can't You Hear Me Knocking: Identification of User Actions on Android Apps via Traffic Analysis. acm. (n.d), p297-304.

[28] Huy Quan Vu , Gang Li , Rob Law and Ben Haobin Ye . (2015). Exploring the travel behaviors of inbound tourists to Hong Kong using geotagged photos. elsevier. 46 (n.d), p222-232.

[29] Alberto Abell , Oscar Romero, Torben Bach Pedersen,Victoria Nebot, Marıa Jose Aramburu and Alkis Simitsis. (2015). Using Semantic Web Technologies for Exploratory OLAP: A Survey. IEEE, p1-21.

ISBN: 978-0-9957075-4-2 DOI: 10.24032/ijeacs/0203/02

[30] Wycombe District Council (2016). Website user behaviour. http://data.wycombe.gov.uk/api/esdInventory

AUTHOR PROFILE

Mrs. N. Pushpalatha working as an Associate Professor in Marri Laxman Reddy Institute of Technology and Management, Hyderabad. She has 10 years teaching experience and good knowledge in computer science courses. She completed B.Tech. & M.Tech. Ccomputer Science & Engineering from University College of Engineering, JNTU Campus, Kakinada. She is presently pursuing Ph.D. from JNTU, Hyderabad, India

An Empirical Study of the Improved SPLD Framework using Expert Opinion Technique

Md. Mottahir Alam
(Ph.D. Scholar), Dept. of Computer Science, Singhania University, Jhunjhunu Rajasthan, India

Asif Irshad Khan
Department of Computer Science
FCIT, King Abdulaziz University
Jeddah, Saudi Arabia

Aasim Zafar
Dept. of Computer Science
Aligarh Muslim University
Aligarh, UP, India

***Abstract*—Due to the growing need for high-performance and low-cost software applications and the increasing competitiveness, the industry is under pressure to deliver products with low development cost, reduced delivery time and improved quality. To address these demands, researchers have proposed several development methodologies and frameworks. One of the latest methodologies is software product line (SPL) which utilizes the concepts like reusability and variability to deliver successful products with shorter time-to-market, least development and minimum maintenance cost with a high-quality product. This research paper is a validation of our proposed framework, Improved Software Product Line (ISPL), using Expert Opinion Technique. An extensive survey based on a set of questionnaires on various aspects and sub-processes of the ISPLD Framework was carried. Analysis of the empirical data concludes that ISPL shows significant improvements on several aspects of the contemporary SPL frameworks.**

Keywords- Software Product Line; empirical study; software reuse; feature coverage; variability; product line methods; feature modeling.

I. INTRODUCTION

The constant demand for developing larger and complex software applications in a limited time and optimal cost tries to find an answer in software reusability. According to K Jordan [1], software reusability is the approach in which software products or applications are realized by implementing pre-existing software assets in an organization. Assets include specifications, library, design, framework, tools, software program, component or some documentation. There are numerous benefits of reusability [2, 3]:

1) Improve timeliness by delivering product in lesser time to market;
2) Lesser maintenance cost;
3) Boost development efficiency
4) Improve consistency of the software design;

Traditionally, software reuse, in general, was not planned and was focused on maintaining software components into a repository in the anticipation that opportunities for future reuse may happen. Nowadays, a number of optimized software reuse approaches have been proposed by the researchers and industries [3]. One such approach is software product line engineering (SPLE) which supports reuse by building tailored products meeting needs of particular market segments. Reuse in SPL is planned in a systematic and efficient manner and is performed for each artifact resulting from the development process. These artifacts are organized and interrelated collection of software components that can be reused across applications.

SPLE manipulates commonalities and variabilities of a set of similar products in an organized way so as to lower development costs, improve quality, and minimize time-to-market. Under this approach, software products are developed around a set of some common components with specific variabilities resulting in different product configurations [4, 5]. As per practical experiences, SPL helps companies to achieve out of bound improvements in development cost, delivery time, product quality, and adaptability [4].

SPLE is generally comprised of 2 main engineering stages: domain engineering and application engineering [6,7]. During domain engineering, the commonality and the variability in the product line are described and implemented. In application engineering, the different product applications are delivered by reusing artifacts developed during domain engineering and manipulating the product line variability. Product development through SPLE is achieved by developing a flexible and reusable product platform [7]. The basic idea of this developmental approach is to separate common parts of a product family from the differences between the products on the basis of domain knowledge. These common features are used to build a platform which is then used as a standard to create a wide range of products in a product family. In the software context, a platform is a set of reusable assets. It acts as a technological base on which software products or applications are built. The differences among these similar products are captured through variability. Variability is the

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capability of software artifacts to vary and its smart management and controlling helps in the realization of successful SPL [8]. It is the flexibility of software artifacts to vary and its smart management and controlling help in the realization of successful SPL [9].

Manufacturing companies like Boeing and Ford have already successfully adopted product line approach to have control over budget and efficiency by taking benefit of common features among similar products. Several other companies like Hewlett-Packard, Motorola, Dell have also been following SPL approach [10]. Although product line is not a new idea for manufacturing companies, it is a comparatively new approach for software companies. However, studies have proved beyond doubt that companies which have implemented product line approach have earned tremendous benefits and achieved momentous improvements in costs, delivery time, reliability, usability, portability and maintenance, and customer satisfaction [6, 11].

Bosch in 2000 proposed that creation of a product line can be categorized into three parts, namely, the vital reusable assets of the product line, the management of the product line and the life cycles of the reusable artifacts of the product line [12]. Researchers, of late, have proposed several approaches to implementing software reuse by amalgamating component-based software development (CBSD) and software product lines (SPL) as it maximizes the software reusability.

This paper is planned as follows: Section II discusses related work in software product line framework. Section III discusses the overview of the improved SPL framework. Section IV describes assessment using expert opinion technique. Section V presents the research findings and section VI provides concluding remarks and future work.

II. Related Work

There are several approaches proposed by researchers to manage software product line development.

Weiss et.al [13] put forward a model for SPLE, called as FAST (Family-oriented abstraction, specification, and translation). It is a feature-based model.

FAST Model supports a major share of common artifacts among themselves when the range of similar products is developed.

Common artifacts are analyzed to create a group of products and that result in building of potential software families with common feature like behavior, interfaces, or code. This helps in making the software development more robust by reusing the common artifacts, which in turn decreases the development cost, and reduces the time-to-market as shown in Figure 1.

The processes in this framework are divided into three sub-processes:

i. **Domain qualification**: In this phase cost benefit analysis is done to study the economic feasibility of the potential product line.

ii. **Domain engineering**: In this phase product line infrastructure, core assets reusability and family definition are analyzed for the potential product line.

iii. **Application Engineering**: In this phase reusable core assets are used to build the product line family.

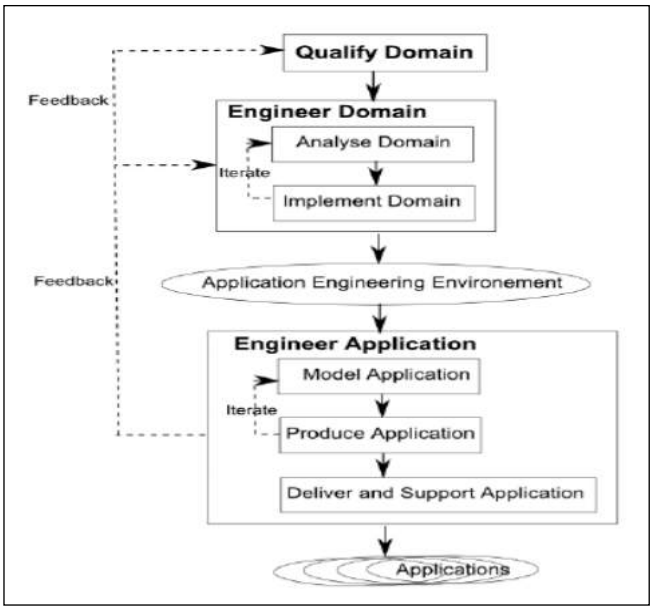

Figure 1. FAST Flow Process [13].

Kang proposed FODA-Feature-Oriented Domain Analysis [14] to identify and model features. This model is based on domain analysis process to identify distinct features within a product line. This approach involves three basic processes, namely,

i) Analysis of the domain of the SPL
ii) Analysis the features of the SPL
iii) Modeling the features of the SPL

Kim, J. et.al [15] in 2008 suggested a framework for implementing both domain requirements as well as modeling core architecture in SPL. It is presented in Fig. 2. The framework uses processes, methods and support tools and shows a mapping between product line requirements and reference architecture. It involves concepts such as goal oriented domain requirement analysis, analytical hierarchy process (AHP), matrix technique and architecture styles.

It performs domain requirement analysis by classifying requirements into four different stages: Business stage, service stage, interaction stage, and internal stage. This helps in identifying and building components.

The next step is to prioritize the components using matrix techniques and analytical hierarchy process (AHP). Finally, reference architecture is created based on the components and their quality attributes.

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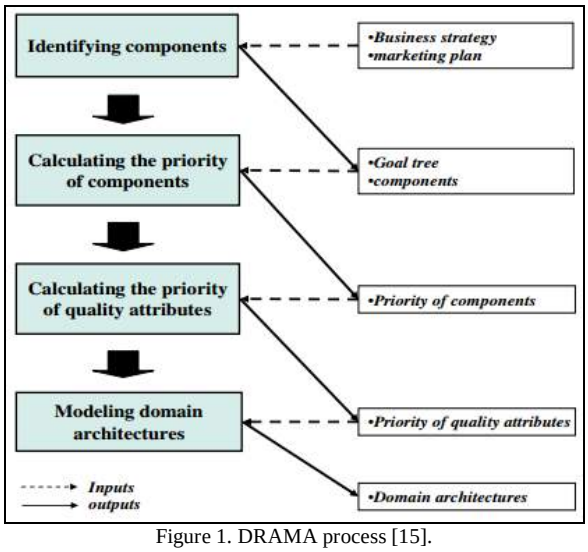

Figure 1. DRAMA process [15].

Tanhaei, M. et.al [16] in 2010 proposed an architecture-based technique to select suitable components in an SPL. It is a component-oriented technique to manage and control the selection of components in an SPL, thereby reducing risks and cost of software development. The components are carefully selected on the basis of the reference architecture, product family requirements, domain requirements, and concerns of stakeholders. The architecture of this method is shown in Fig.3. It starts with the selection of a component list from the component lists on the basis of architecture variant point.

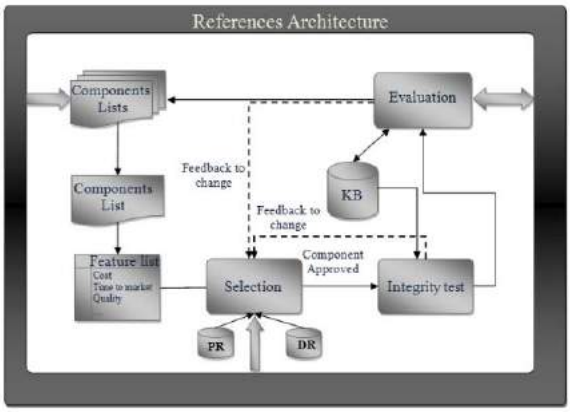

Figure 3. Architecture of method [16].

The components in the component list can be selected either from COTS components or component repository. If the component is not available, then it is developed. The selected components are evaluated for approval. Once approved, these components are passed through integrity test. Lastly, reference architecture is obtained these selected and successfully tested components. Mellado, D et.al [17] gave a framework which emphasizes on security mechanisms for SPL as shown in Fig.4. This framework categorizes activities into two main types: application engineering and domain engineering. It implements security by integrating domain security mechanism PLSecDomReq and application security mechanism PLSecAppReq.

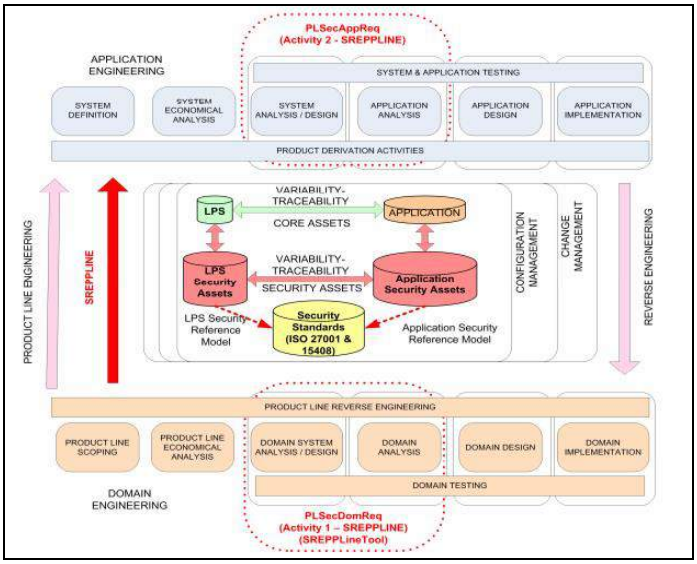

Figure 4. Security requirements engineering framework for Software Product Lines [17].

The reference architecture involves repositories, traceability, and security mechanism. The various repositories implemented in the framework are:

1) Software product line repository
2) Application repository
3) SPLSecurity Assets Repository
4) Application Security Asset Repository
5) The Security Standards Repository

III. Overview Of The Improved SPL Framework

A security enabled framework for software product line development is proposed with a high abstract level of software product line (SPL) architecture as shown in Fig5. The model is a mix of aspect-oriented and the feature-oriented approach. The aspect-oriented approach addresses crosscutting concerns and functional behaviors of SPL while the feature-oriented approach is used to capture variability and commonality of product lines. The detailed explanation of the proposed model is as follows.

The model has two high-level processes: domain engineering and application engineering. The main aim of domain engineering is to identify and develop reusable artifacts for reuse later in the application engineering phase. Application engineering targets building of software products using the identified reusable artifacts.

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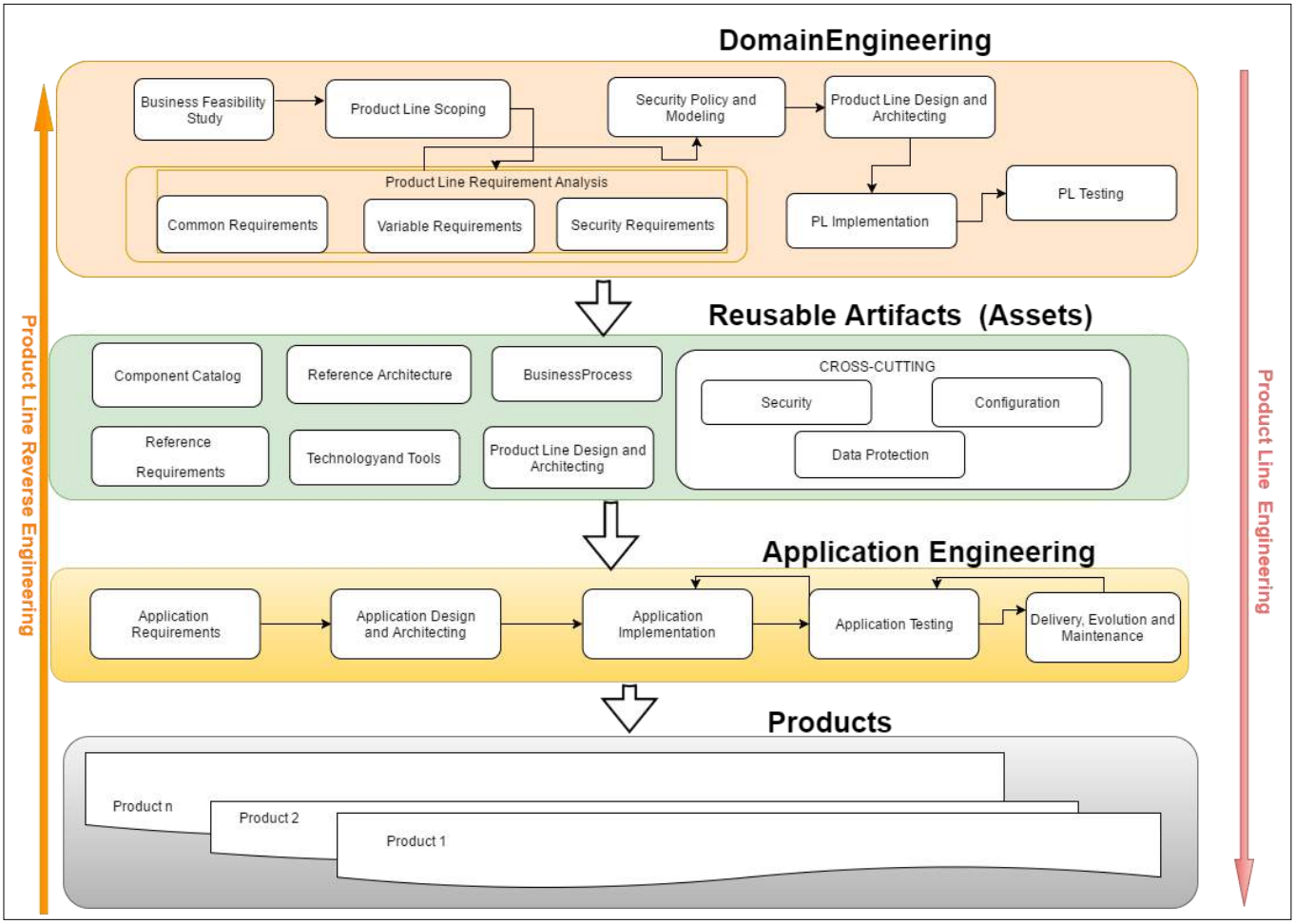

Figure 5. Shows a high abstract level of Software Product Line (ISPL) Architecture.

A. Domain Engineering Phase

Domain Engineering requires common and variable requirements of the product line family as inputs and generates reusable core assets such as components, framework, a library, tools or a platform, etc. The core activities of the domain engineering phase are described as follows:

- Business Feasibility Study
- Product Line Scoping
- Product Line Requirement Analysis
- Security Policy and Security Modeling
- Product line design and architecting
- Product line Implementation
- Product line Testing

B. Application Engineering Phase

Application engineering deals with requirements specifications of individual products of the software product line family are considered, and a customer-specific product is developed by using the generic architecture and reusing the core assets from domain engineering as much as possible.

Following are the major activities carried out to create tailored products during application engineering:

- Application Requirement
- Application Design and Architecting
- Application Implementation
- Application Testing
- Delivery, Evolution, and Maintenance

For a detailed description, refer to [7].

IV. Assessment Using Expert Opinion

Expert opinion technique was utilized to assess and validate different phases of the proposed SPL framework. This method is very useful in evaluating certain system specific questions linked to system behavior, usability and reusability as well as system performance and uncertainties [18]. It also utilizes the wide range of knowledge and expertise of the experts to evaluate the product 19]. Many researchers have used this technique and some scientific publications have emphasized the reliability of using this tool. Authors have conducted expert opinion surveys to validate their system process improvement frameworks and have found this method very trustworthy [20]. Expert opinion technique to solicit the feedback of experts on a process model is has been found to be very useful to validate the framework informally [21].

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In this empirical research, the view was sought from experts to evaluate different phases of proposed SPL framework architecture based on the core aims of our research.

A questionnaire comprising of 10 items based on different processes of the proposed framework was created. Experts from software development companies, software vendors, and academics were invited to participate in the research survey.

The following criteria were considered while inviting the survey participants:

1) Currently working as a software architect or system designer or software programmer with more than six years of experience.
2) Should have expertise and skill in using state of the art SPL framework and tools.
3) Should be willing to work as an unbiased evaluator.
4) Should be willing to commit time and effort to offer a valuable opinion based on his working or research experience.

The format of the questionnaire contains statements based on each phase of the proposed SPL framework and respondents were required to give their opinions about the statements in the form of degree of their agreement/disagreement with the statement. We employed the Likert scale which is invented by psychologist Rensis Likert. It is a psychometric response scale and has ratings 1 to 5. It is also called as rating scale and is used by academicians and researchers in surveys to find participants' degree of agreement/disagreement with a specific statement or group of statements. Table1 summarizes the Likert scale employed in this survey.

TABLE 1

5	Very high / Outstanding / Highly
4	High / Considerable / Moderately
3	Nominal / Average / Nominally
2	Low / Nominal / Poorly
1	Very low / Poor / Irrelevant

The results of our analysis were represented using bar charts and frequency tables depicting the extent of analysis. Selection of software experts to invite for the research survey is the most important activity of the empirical research. The basic goal of this empirical investigation and analysis is to validate the proposed SPL framework that ensures a common core SPL architecture achieving write one-time and reuse many- time policy with no or slight variation, which results in reduced development time, improved productivity, and quality product.

V. RESEARCH FINDING

The evaluation of our proposed framework is performed by using a survey method involving software experts from industry as well as academics to validate the different aspects addressed in the given framework. The authors evaluate issues by performing a cumulative evaluation of the various features and concerns in the proposed framework. We sent a questionnaire to 70 software experts in different software companies and colleges around the world. A total of 52 responses was received out of the total 70 questionnaires sent. The remaining 18 couldn't send their responses until the time of our analysis. Of the 52 responses received, six were not included in our analysis as either they were incomplete or didn't meet our criteria for selection. Table 2- shows different abbreviations used in our Analysis Tables and its description.

A. Evaluation of addressing Reusability in the product line

The software product line engineering is based on the concept of software reusability. The proposed framework improves the software reusability in every aspect of the product family. Analysis of the survey concludes that 20% of the responded strongly agreed and 62% agreed that the reusability is addressed in a planned and systematic manner in the framework. Also, approximately 11% of the respondents are unsure of the reusability concern as addressed in the framework while 7% of the respondents don't agree on the reusability concerns in the framework.

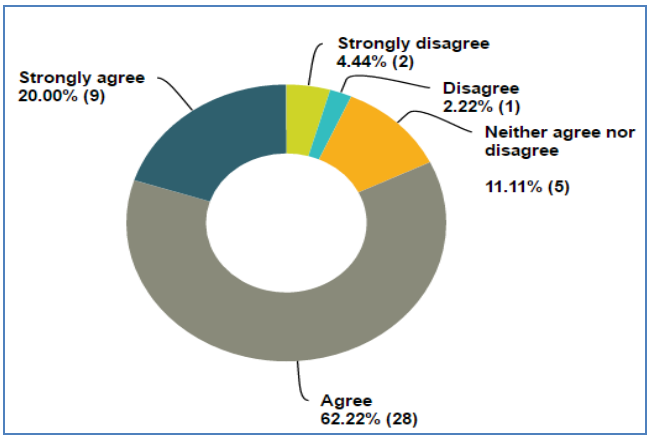

Figure Donut chart of respondent responds to the issue addressed in the proposed framework. Overall, the majority of the respondents gave a positive rating to the proposed framework on this issue.

Answer Choices	Responses	
Strongly disagree	4.44%	2
Disagree	2.22%	1
Neither agree nor disagree	11.11%	5
Agree	62.22%	28
Strongly agree	20.00%	9
Total		45

Figure shows of respondents' responses to the issue addressed in the proposed framework.

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B. Evaluation of Security, Data Protection, and configuration issues

The framework addressed the cross-cutting concerns such as security and data protection issues in a product line from the early stages of the product line development as retrofitting security in the later stages might break the product line architecture.

Answer Choices	Responses	
Strongly disagree	0.00%	0
Disagree	2.17%	1
Neither agree nor disagree	8.70%	4
Agree	76.09%	35
Strongly agree	13.04%	6
Total		46

Figure respondent responds to the issue addressed in the proposed framework.

As per the survey, 13% strongly agreed while 76% agreed that the proposed framework covers the cross-cutting concerns of the product line in all the stages of domain and application engineering.

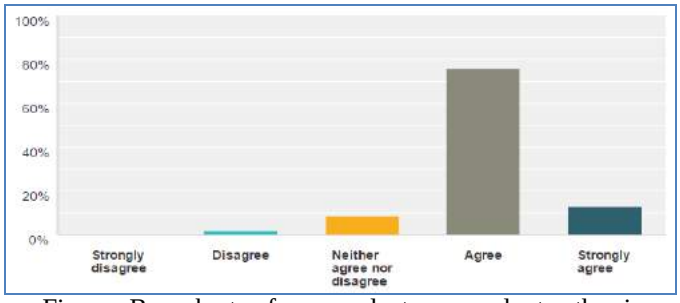

Figure Bar chart of respondent responds to the issue addressed in the proposed framework.

Overall, the framework voted positive rating on this issue. Hence, the respondents considered that our framework succeeded in addressing the cross-cutting concerns from the early stages of the domain engineering till the application engineering of the product family.

C. Evaluation of the commonality and variability aspects

Software product line is built around a set of common software components with points of variability that allow a wide range of products within a product family. We analyzed the responses of the experts on this issue and found that majority of the respondents gave the positive rating to the proposed framework on this issue. As per survey data,

91% of the respondents either strongly agreed or agreed that the proposed framework addresses the key concepts of commonality and variability. Hence, it is concluded that the commonality and variability aspects are also well addressed in the proposed framework.

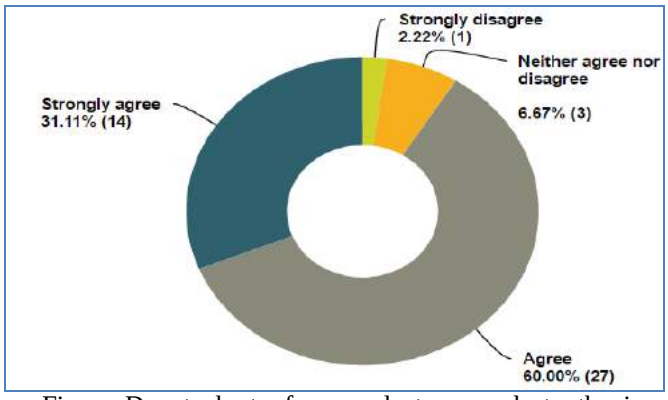

Figure Donut chart of respondent responds to the issue addressed in the proposed framework.

Answer Choices	Responses	
Strongly disagree	2.22%	1
Disagree	0.00%	0
Neither agree nor disagree	6.67%	3
Agree	60.00%	27
Strongly agree	31.11%	14
Total		45

Figure respondent responds to the issue addressed in the proposed framework.

D. Result of evaluation for the use of ADLs to support variability

Architecture description languages (ADLs) provide support for capturing variation points. It is recognized as an important element in the description and analysis of software properties. It allows describing of variable and dynamic features in the SPL. However, not all ADLs provide support for capturing variation points.

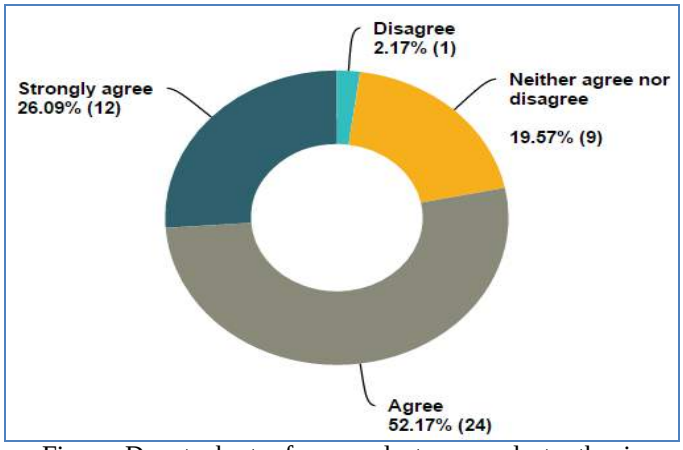

Figure Donut chart of respondent responds to the issue addressed in the proposed framework.

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Answer Choices	Responses	
Strongly disagree	0.00%	0
Disagree	2.17%	1
Neither agree nor disagree	19.57%	9
Agree	52.17%	24
Strongly agree	26.09%	12
Total		46

Figure Bar chart of respondent responds to the issue addressed in the proposed framework.

The use of variability-supportive ADLs in the Product line design and architecting phase of the proposed framework is validated, and it is found that 26% of the respondents strongly agreed while 52% agreed that ADLs used in the SPLE should be supportive variability. Overall, 78% respondents agreed that the use of variability-supportive ADLs as suggested in the proposed framework is the best way to incorporate variability in the SPLE. Also, approximately 20% of the respondents were neutral on this matter.

E. Evaluation of Documentation, Tagging and Repository aspects

Documentation is one of the reusable assets under the concept of software reusability in the SPLE. In this proposed framework, various aspects of a software product line development such as business feasibility study, scope, objectives, and evolution of the product line are recommended to be documented. Besides, the product line requirements, architecture design documents, test plan, test design, test cases, etc. should also be developed and well documented. It should also include component's design, its documentation, its test design and procedures, and any models to predict its behavior. All these documents must be maintained so as to be used as reusable assets throughout the lifetime of the product line.

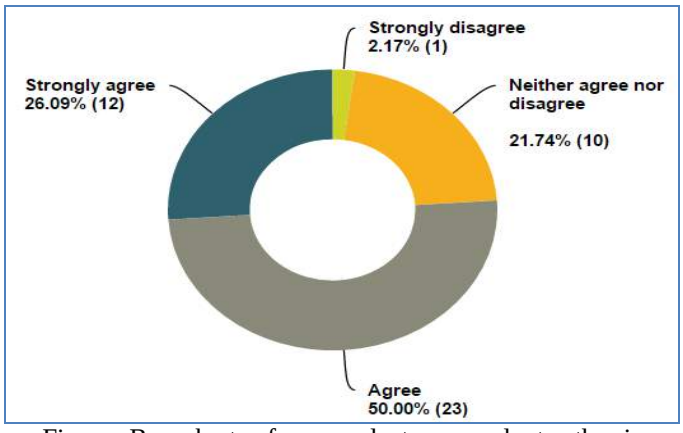

Figure Bar chart of respondent responds to the issue addressed in the proposed framework.

The analysis of the data shows that proposed framework through experts' opinion and found that 26% of the respondents strongly agreed while 50% agreed that reusable artifacts present in the component catalog and repository should be documented and maintained throughout the lifetime of the software product line as mentioned in the proposed SPL framework.

Answer Choices	Responses	
Strongly disagree	2.17%	1
Disagree	0.00%	0
Neither agree nor disagree	21.74%	10
Agree	50.00%	23
Strongly agree	26.09%	12
Total		46

Figure respondent responds to the issue addressed in the proposed framework.

Overall, 76% of the respondents gave a positive rating to the framework.

F. Evaluation of the configuration management aspect in the proposed framework

In a software product line, individual products are built, using selections and configurations of the reusable components as well as the implementation of product-specific features. The configuration comprises of the selection of possible variants for a specific application.

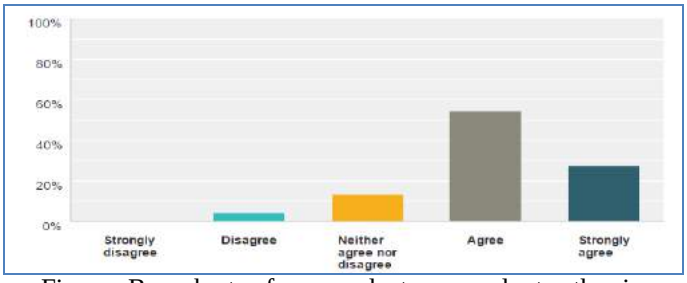

Figure Bar chart of respondent responds to the issue addressed in the proposed framework.

The products are abstracted by configuring the architecture and tailoring components available in the component catalog. It picks and configures the compulsory parts of the reference architecture and adds in product specific variations to yield unique products of a software product family.

Answer Choices	Responses	
Strongly disagree	0.00%	0
Disagree	4.55%	2
Neither agree nor disagree	13.64%	6
Agree	54.55%	24
Strongly agree	27.27%	12

Figure respondent responds to the issue addressed in the proposed framework.

As per the survey data, the majority of the respondents agreed that the configuration aspect is well managed in the proposed framework. 27% of the respondents strongly agreed while 54% agreed that the configuration management is covered in the proposed SPL frame. Also, around 4.5% didn't agree while around 13% didn't have any opinion on this issue. Hence, the empirical study positively validates the proposed framework on this aspect.

G. Result of evaluation to validate whether the proposed framework addresses the testing concerns

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In an SPL, every product of a product family is based on a unique set of features. Since SPLE technology is applied to increasingly complex domains, the need for an efficient product testing approach becomes more critical. Furthermore, a product line grows over time to meet new demands of the market, some enhancements or corrective modifications. To make sure that these changes in are in conformance with the product line core architecture, do not bring unforeseen errors, and the new features work as expected, rigorous testing needs to be performed. As per the survey data, the majority of the respondents agreed that the testing aspect is well covered in the proposed framework. 11% of the respondents strongly agreed while 68% agreed that the configuration management is covered in the proposed SPL frame. Also, around 2.2% didn't agree while around 15.5% didn't have any opinion on this issue. Hence, the empirical study positively validates the proposed framework on the testing aspect.

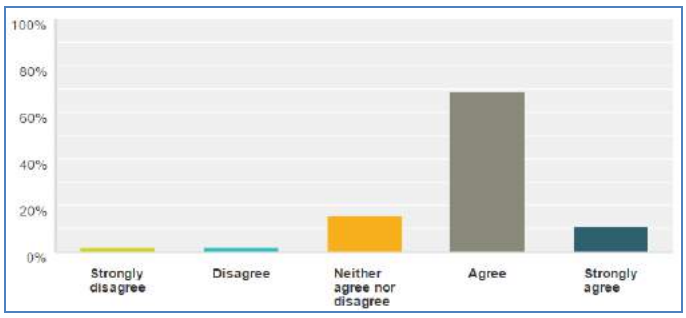

Figure Bar chart of respondent responds to the issue addressed in the proposed framework.

Answer Choices	Responses	
Strongly disagree	2.22%	1
Disagree	2.22%	1
Neither agree nor disagree	15.56%	7
Agree	68.89%	31
Strongly agree	11.11%	5
Total		45

Figure respondent responds to the issue addressed in the proposed framework.

H. Overall Evaluation Results for the ISPL Framework

Overall, most of the evaluation criteria for the ISPL Framework got positive ratings, and hence, it is concluded that the experts found significant improvement in our ISPLD framework.

Clearly, the framework thrives to achieve improvement in almost every phase of the software product line development, i.e. from business feasibility, study and product line scoping to application implementation and testing.

VI. CONCLUSION

The proposed framework, ISPLD, has been empirically studied and analyzed in this paper using expert opinion technique.

We conducted an extensive survey based on a set of questionnaires on various aspects and sub-processes of the ISPLD Framework. The participants were chosen from software product development firms, software vendors, and academicians. Survey result shows that majority of the expert give positive feedback on the ISPL Framework. The result of analysis concluded that ISPLD framework brings significant improvements.

REFERENCES

[1] Kimberly Jordan. Software Reuse, Term Paper for the MJY Team Software Risk Management WWW Site, 21 April 1997. Accessed: February 2010, www.baz.com/kjordan/swse625/docs/tp-kj.doc.

[2] Bertrand Meyer. Object-Oriented Software Construction. Prentice Hall PTR, 2nd edition, 2000.

[3] Alam, M.M, Khan, A.I, Zafar, A., "A Comprehensive Study of Software Product Line Frameworks", International Journal of Computer Applications (0975 – 8887) Volume 151 – No.3, October 2016.

[4] Clements, P., Northrop, L.: Software Product Lines: Practices and Patterns. Addison-Wesley (2001)

[5] Van der Linden, F., et al.: Software Product Lines in Action: The Best Industrial Practice in Product Line Engineering. Springer (2007)

[6] K. Pohl, G. B¨ockle, and F. J. v. d. Linden, Software Product Line Engineering: Foundations, Principles, and Techniques.Secaucus, NJ, USA: Springer-Verlag New York, Inc., 2005.

[7] Alam, M.M, Khan, A.I, Zafar, A. Md. Mottahir Alam, Asif Irshad Khan, and Aasim Zafar. A Secure Framework for Software Product Line Development. International Journal of Computer Applications 159(4):33-40, February 2017.

[8] M. Svahnberg, J. van Gurp, and J. Bosch. A taxonomy of variability realization techniques. Softw., Pract. Exper., 35(8):705–754, 2005.

[9] Khan, A.I., Alam, M.M., Jedaibi, W.A., January 2015. "Variability Management in Software Development using FeatureIDE: A Case Study." International Journal of Scientific & Engineering Research, Volume 6, Issue 1, 584 ISSN 2229-5518

[10] SPL Hall of Fame, http://splc.net/fame.html

[11] K. Mohan, B. Ramesh, and V. Sugumaran, "Integrating software product line engineering and agile development,"Software, IEEE, vol. 27, no. 3, pp. 48–55, 2010.

[12] Bosch, J. (2000). Design & Use of Software Architectures, Addison-Wesley

[13] Weiss, D., Software Synthesis: The FAST Process, Proc. Computing in High Energy Physics 95, September 1995

[14] K. Kang, S. Cohen, J. Hess, W. Nowak, and S. Peterson. Feature Oriented Domain Analysis (FODA) Feasibility Study. Technical Report CMU/SEI-90-TR-21, Software Engineering Institute, Carnegie MellonUniversity, Pittsburgh, PA, USA, November 1990.

[15] Kim, J., Park, S., Sugumaran, V.,2008. "DRAMA: A framework for domain requirements analysis and modeling architectures in software product lines." Journal of Systems and Software, 81(1), 37-55.

[16] Tanhaei, M., Moaven, S., Habibi, J., 2010. "Toward an architecture-based method for selecting composer components to make software product line." Proceedings of the 2010 Seventh International Conference on Information Technology: New Generations (ITNG) (pp. 1233-1236).

[17] Mellado, D., Fernández, M. E., Piattini, M., 2010. "Security requirements engineering framework for software product lines." Information and Software Technology, 52(10), 1094-1117.

[18] Ali B M, Kitchenham B, Assessment of a Framework for Comparing Software Architecture Analysis Methods. Proceedings of 11th International Conference on Evaluation and Assessment in Software Engineering, BCS, 2007.

[19] Matthias R, Tools & Techniques Expert Opinion, Online available http://www.idemployee.id.tue.nl/g.w.m.rauterberg/lecturenotes/UFTexpertopinion.pdf

[20] Sajid R., Moving Towards Component Based Software Engineering in Train Control Applications, Final thesis, Linköpings universitet, 2012, Sweden.

[21] Kitchenham B, et al., An empirical study of maintenance and development estimation accuracy. Journal of Systems and Software, 2002, 64 (1), 57-77.

AUTHOR PROFILE

Mr. Md Mottahir Alam is a Ph.D. scholar in the Computer Science & Engineering in Singhania University, India. He has six years of experience as Software Engineer (quality) for leading software multinationals, where he worked on projects for companies like Pearson and Reader's Digest. He is ISTQB Certified Software Tester. He has received his Bachelor's degree in Electronics & Communication and Masters in Nanotechnology from Jamia Millia Islamia University, New Delhi, India. Mr. Alam research interest includes Software Engineering esp. Software Product Line Engineering, Software Reusability, Component-based and Agent-based Software Engineering.

Dr. Asif Irshad Khan is working as a faculty member in the Department of Computer Science, FCIT, King Abdulaziz University, Jeddah, Saudi Arabia. He has thirteen years of experience as a professional academician and researcher. Dr. Khan received Ph.D. in Computer Science and Engineering from Singhania University, Rajasthan, India, and Master & Bachelor degrees in Computer Science from the Aligarh Muslim University (A.M.U), Aligarh, India. He has published several research articles in leading journals and conferences. He is a member of the editorial boards of international journals, and his current research interest includes Software Engineering with a focus on Component Based and Software Product Line Engineering.

Dr. Aasim Zafar is working as an Associate Professor in the Computer Science Department, AMU, Aligarh. His current research interest includes e-learning, mobile learning, virtual learning environments and mobile ad hoc networks. He received his Ph.D. degree in Computer Science from the Aligarh Muslim University, India. He has a number of research papers to his credits. Dr. Zafar is a member of Internet Society (ISOC). He is a member of several editorial boards and a regular reviewer for reputed journals.

Anatomical Survey Based Feature Vector for Text Pattern Detection

Samabia Tehsin
Department of Computer Science
Bahria University Islamabad Campus
Islamabad, Pakistan

Sumaira Kausar
Department of Computer Science
Bahria University Islamabad Campus
Islamabad, Pakistan

***Abstract*—The vital objective of artificial intelligence is to discover and understand the human competences, one of which is the capability to distinguish several text objects within one or more images exhibited on any canvas including prints, videos or electronic displays. Multimedia data has increased rapidly in past years. Textual information present in multimedia contains important information about the image/video content. However it needs to technologically verify the commonly used human intelligence of detecting and differentiating the text within an image, for computers. Hence in this paper feature set based on anatomical study of human text detection system is proposed.**

Keywords- Biologically-inspired vision; Content-based retrieval; Document analysis; Text extraction.

I. INTRODUCTION

There are very strong reasons to believe with substantial evidences that the first and foremost creation of universe would be a pen, which draws and writes. This writing develops into a plan to be manifested in shape of a logical working of every tier of all known and unknown galaxies. Even today in times of technological advancements and scientific progression, we could avoid only little about pen but not at all about writing. We write to read, teach, prove, plan, assimilate and disseminate. This all is worth proofing the very importance of alphabets, words, sentences and nevertheless, languages to understand.

In recent years there is a rapid increase in multimedia libraries, which raise the need of efficiently retrieving, indexing and browsing multimedia information. Several approaches have been introduced in the literature to retrieve image and video data. These techniques are based on color, texture, shape and relation between objects etc. For text based queries, text embedded in images and videos for retrieval is a very good option.

Visual texts appearing in multimedia data often impart knowledge about news headings, title of movie, brands of products, scores of a match, date and time when an event took place. All this information is vital for understanding and retrieving images and videos.

Text extraction and recognition process comprises of five steps namely text detection, text localization, text tracking, segmentation or binarization, and character recognition.

Text detection and localization are the primary steps in text extraction process. Different features are used in the literature to detect the text in the image. Mostly, these features are imported from other applications of computer vision and pattern recognition and these features are targeting the specific set of images. Most appropriate way of defining the text extraction features is to study the human brain operations and features used by humans to extract the text. No formal survey or study is conducted in the literature to study the human text detection system. This paper present the study of human text detection method and intelligent framework is presented to study the anatomical feature set used for text detection. Feature set describing the text objects in the image is also concluded.

The rest of the paper is organized as follows. Section II highlights some related work of the field. Section III proposes an intelligent framework to extract text detection features. Section IV presents the dataset used and results of the survey and section V provides some concluding remarks.

II. LITERATURE REVIEW

A variety of approaches of text extraction have been proposed during the past years. [1]-[10]. Comprehensive surveys can be found in [11]-[14]. But very less work has been done in defining the novel feature vectors for text detection. Most of the existing systems use few conventional features to classify text and non text objects. These features are generally defining few geometrical features of the text objects.

Zhong et al. [15] used a CC-based method using color reduction. They quantize the color space using the peaks in a color histogram in the RGB color space. Each text component goes through a filtering stage using heuristics, such as area, diameter, and spatial alignment.

Two geometrical constraints are applied by Wolf and Jolion [16] to eliminate the non text and detect the text objects from videos. One is the width to height ratio and the second one is number of text pixels of the component to area of the bounding box.

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Simple rules are used by Ezaki [17] to filter out the false detections. They imposed constraints on the aspect ratio and area to decrease the number of non-character candidates. Isolated characters are also eliminated from the text candidate list.

Hua et al. [18] used the constraints on height and width of the text candidates to reduce the false alarms. They also defined fill factor constraint to further reduce the non text objects. They defined the upper and lower limits for ratio of horizontal edge points to vertical edge points. They have also defined the upper limit for the ratio of edge points to total number of pixels in the area. Here the edge points represent horizontal edge, vertical edge and overall edge.

Epshtein et al. [19] present a novel image operator that seeks to find the value of stroke width for each image pixel, and demonstrate its use on the task of text detection in natural images. Many of the recent techniques are using this operator as part of text detection feature vector.

Local binary pattern is being used by Wei and Lin [20] for texture analysis. They first extracted the statistic feature of each text candidate by resizing each text candidate to 128x128 size. They then used Haar wavelet transform to decompose the text candidate to the four sub-band images including: low frequency (LL) band, vertical high frequency (LH) band, horizontal high frequency (HL) band and high frequency (HH) band. Next, they calculated the features in four sub-bands including mean, standard deviation and entropy of each sub-band. In addition to these statistic features, five features of the gray-level co-occurrence matrix (GLCM); energy, entropy, contrast, homogeneity and correlation, are calculated for each four direction in four wavelet sub-bands. 92-dimensional feature vector for each text candidate was generated, which was reduced to 36-dimensions using the principal component analysis (PCA).

After applying the morphological dilation on detected corner points in the image, [21] used five region properties as the features to describe text regions. These features are area, saturation, orientation, aspect ratio and position. The area is the foreground pixels in the bounding box. Saturation specifies the proportion of the foreground pixels in the bounding box that also belong to the region. Orientation is defined as the angle between x-axis and the major axis of the ellipse that has the same second-moments as the region. Aspect ratio of the bounding box is defined as the ratio of its width to its height. Position is defined by the region's centroid.

Shivakumara et al. [22] used two features to eliminate the false positives. One is the straightness and the other one is The first feature, straightness, comes from the observation that text strings appear on a straight line (their assumption), while false positives can have irregular shapes. The second feature, edge density, is defined as the ratio of edge length to the connected component area. Ranjiniand and Sundaresan [23] used the area to find the text area blob.

There is a need of in-depth study of text structures. Anatomical study of human text detection can be useful for identification of such features. And there is also a need to mathematically model those bio inspired features to make it workable for machines. Detailed geometrical and statistical study of text objects is also required.

III. Methodology

Humans are very good in detecting text in the images and scenes around them. So it's very important to study the anatomical text detection system before deciding the features for machines, to detect text. This is the reason that the intelligent framework to study the human text detection system is presented and testified in this paper.

People won't be able to answer if direct investigation about the features of text and nontext objects is carried out. So an indirect framework is designed so that features can be summarized. First the dataset containing the text images is collected with variation in font, color, size and language of the text.

TABLE 1. Parameters of proposed framework

Parameter	Possible Values	
Language	Known	Unknown
Regularity	Symmetric	Non symmetric
Density	Single	Group
View	Distant	Close

Framework is designed by observing the little child who is yet in age of learning any specific language of world. Till he does not know how to read and write any language, he does not have even the idea of difference between a drawing and writing, but then he gets to know spelling of words, way of writing a specific language and development of words into sentences. Actually this is the time he starts differentiating between what is drawn and what is written, though he yet does not know, how to read or write all known languages less one, he is taught. But keeping in mind the way of writing and specific texture of words, running in a regular scheme as a reference, he can make out that the one displayed in front of him is a text and not a simple drawing. So he can detect and differentiate now, though yet cannot assimilate to read.

Based on this observation, it is deduced that recognition and detection are two different processes. In order to get the separate observations for detection and recognition, language is considered as the parameter in the framework. So text of known as well as unknown language is added to the dataset. In order to emphasize this point, two views are introduced in the framework. One is the close view, that is distance between the viewer and the text image is very less, that the person is able to see and assimilate the text. Other one is the distant view, in this the person can see but not able to assimilate the text .e.g. small

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text appeared on billboard viewed from the distance can be seen but can't be read.

Other two parameters are the symmetry and density of words. Symmetric text is the one having same height, size, font and color for all characters, aligned in some specific direction. Non symmetric text misses all or some of the features of symmetric text.

(a)

(b)

Figure 1. (a) Isolated Characters (b) Text in monograms (Irregular text)

Four parameters and their possible values defined in the framework to explore the text features are shown in table 1.

For the sake of clarity, parameters are defined here. Known language is the language whose writing style is familiar to the viewer and unknown language is one with the alien writing style. If a person can read and write the English language only, the Spanish and Korean would be unknown language for that person. Regular text is the text with symmetry e.g. news credits and irregular text is the text without symmetry, which normally appears in the monograms and product labels. Examples of different text groups of images are presented in fig. 1. View is defined in terms of distance of viewer from the text. Close view is the one, text can be seen and read comfortably and it is distant view if text can be seen but cannot be read.

Twelve different groups are formulated by combination of above mentioned parameters. These groups can be observed through the parameter tree shown in fig. 2. Alphabetical tag (A-L) is attached to each of these groups. For example, Label 'A' is assigned to the group with isolated character of a known language, which is viewed from distance.

IV. Dataset and Results

A. Dataset

Dataset includes images with variety of text styles. Dataset includes text with variation in font, style, color and language.

Dataset also include the artistic text, text in monograms, isolated and grouped characters.

Dataset is divided into six test sets; these are:

A. Isolated characters of known language
B. Isolated characters of unknown language
C. Grouped characters of known language, with symmetry
D. Grouped characters of known language, without symmetry
E. Grouped characters of unknown language, with symmetry
F. Grouped characters of unknown language, without symmetry

Twenty images of each category are included in the dataset; which makes the total of 120 images in the dataset. Some images from the dataset are presented in the fig. 3

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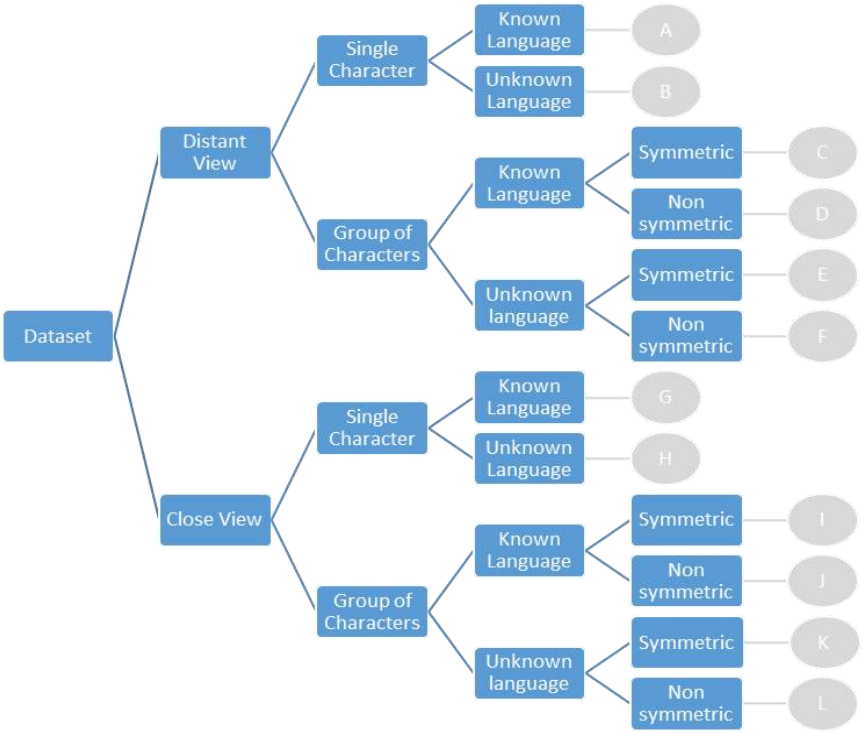

Figure 2. Parameter Tree

Figure 3. Sample dataset images

B. Participants

Fifty individuals, ranging in age from 7 to 12 years, completed the survey. This age group is chosen because;

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people of this age group usually have reading and writing knowledge of only one language. The people below this range may not have knowledge of reading and writing any language. People age above this age group may have knowledge of many languages or they have developed the knowledge of relating different facts to detect text in the image.

C. Results

Six test sets of dataset are checked under two conditions; distant view and close view. Parameter tree in fig. 2 describes all the possible test cases for the experimentation. Dataset categories (1-6) for distant view is represented by (A-F) in parameter tree and (G-L) characterize close view cases.

Table 2 shows the results of the carried out experiments. Test Case shows the labels associated to each case in the parameter tree. Next four columns represent different possible values for the parameters of framework. Last column represents the accuracy of the detection. Accuracy is computed by

$$\text{Accuracy} = \frac{\text{Correctly detected objects}}{\text{Total number of text objects}} \text{ X } 100$$

TABLE 2. Results of the experiments for different values of the parameter

Test Case	View	Density	Language	Symmetry	Accuracy
A	Distant	Single	Known	-	28%
B	Distant	Single	Unknown	-	17%
C	Distant	Group	Known	Symmetric	99%
D	Distant	Group	Known	Non-Symmetric	39%
E	Distant	Group	Unknown	Symmetric	97%
F	Distant	Group	Unknown	Non-Symmetric	35%
G	Close	Single	Known	-	100
H	Close	Single	Unknown	-	34
I	Close	Group	Known	Symmetric	100
J	Close	Group	Known	Non-Symmetric	99
K	Close	Group	Unknown	Symmetric	99
L	Close	Group	Unknown	Non-Symmetric	41

Figure 4 shows the result of the experimentation. In the figure horizontal legends show the different test sets defined in the dataset section. Vertical legends show the accuracy of the detection process. Experiments show that test sets three and five give very good detection results both for distant and close view. Common parameters between these test cases were the grouped characters and symmetry of text. It means if the characters are grouped and are in some symmetry, text will get detected whether seen closely or from distance. In other words, text would get detected whether recognized or not.

Text detection gives poor results for category four and six, except when of known language and viewed from nearby. It means if symmetry is not there in text, it won't be detected unless recognized.

From the study of test cases one and two, it is clear that isolated characters are detected only if of known language and viewed closely.

From the above discussion it can be concluded that text detection and recognition are two different stages for human text vision system. Text can be detected in following conditions:

- Text should be symmetric, that is it should have equal gaps between the characters and words and height of the characters should be approximately same.
- Text should be in groups i.e. it should be combination of three or more characters

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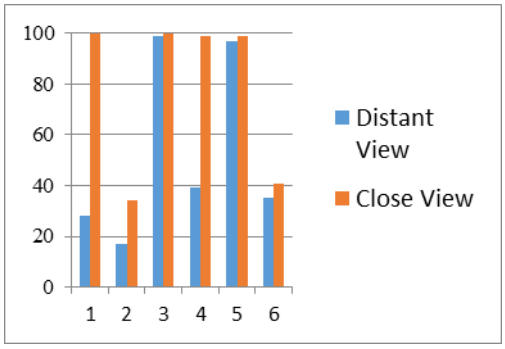

Figure 4. Results of experiments

If above two features exists in the text that can be detected from distant as well as from close view. It will be detected whether it is of known language or unknown language. But if text lacks the above mentioned features, it can only be detected if recognized. So the above mentioned features are necessary to detect the text without recognition i.e. without knowing the shape of the alphabets of language.

So in order to detect the text before the recognition process, symmetry of the text can be exploited. This symmetry may includes

- Periodic gaps between characters.
- Even distribution of foreground object.
- Constant instantaneous height of text object.
- Ratio of background and foreground remains almost same throughout the object.

These features can be used for the text detection process. So there is a need to develop the mechanism for regular and irregular texts separately. Humans can even detect the text of unknown language, where they cannot recognize the characters and words. However the criterion remains, that common features between languages, that is a regular scheme of words and texture prevails. Whereas to read a specialized text, like monograms and logos, where texture of words and sequence may vary, one may know the difference of a drawing or a text only when he knows the specific language in which it is written. This means, that to read an uncommon and irregular writing, the brain of human needs to assimilate first, and to read afterwards.

V. Conclusion

In this paper an intelligent framework is designed to explore the features, used by human to detect text in the image. This framework consists of four parameters, each having two possible values. Total twelve test cases can be formulated with the combination of these parameters. These test cases are tested by the fifty observers and it is deduced that text detection and recognition are two separate steps in the human text detection system. In some cases detection is carried out without recognition and in other cases detection is done through the recognition. In the later cases detection won't be possible without recognition.

From the experimentation it is observed that if detection has to be carried out without the recognition process; following features should exist in the text; one is symmetry and other one is the group of characters. If either of the features is missing from the text, text cannot be detected unless recognized.

Mathematical representation of feature vector can also be formulated as future research work.

References

[1] H. P. Li, D. Doermann, and O. Kia. Automatic text detection and tracking in digital video. IEEE Trans. IP, 2000.

[2] Tehsin, Samabia, et al. "Text Localization and Detection Method for Born-digital Images." IETE Journal of Research (Medknow Publications & Media Pvt. Ltd.) 59.4 (2013).

[3] K. I. Kim, K. Jung, and J. H. Kim. Texture-based approach for text detection in images using support vector machines and continuously adaptive mean shift algorithm. IEEE Trans. PAMI, 2003.

[4] Tehsin, Samabia, et al. "Fuzzy-Based Segmentation for Variable Font-Sized Text Extraction from Images/Videos." Mathematical Problems in Engineering2014 (2014).

[5] M. Zhao, S. T. Li, and J. Kwok. Text detection in images using sparse representation with discriminative dictionaries. IVC, 2010.

[6] K. Wang and S. Belongie. Word spotting in the wild. In Proc. ECCV, 2010.

[7] Tehsin, Samabia, et al. "A CAPTION TEXT DETECTION METHOD FROM IMAGES/VIDEOS FOR EFFICIENT INDEXING AND RETRIEVAL OF MULTIMEDIA DATA." International Journal of Pattern Recognition and Artificial Intelligence (2014).

[8] L. Neumann and J. Matas. A method for text localization and recognition in real-world images. In Proc. of ACCV, 2010.

[9] P. Shivakumara, T. Q. Phan, and C. L. Tan. A laplacian approach to multioriented text detection in video. IEEE Trans. PAMI, 2011.

[10] Samabia Tehsin, and Asif Masood (2014), "Geometrical Analysis Based Text Localization Method", Int'l Conf. IP, Comp. Vision, and Pattern Recognition (IPCV'14), pp 554-560

[11] K. Jung, K. Kim, and A. Jain. Text information extraction in images and video: a survey. PR, 2004.

[12] J. Liang, D. Doermann, and H. Li. Camera-based analysis of text and documents: a survey. IJDAR, 2005.

[13] C.P. Sumathi, , T. Santhanam, and G.Gayathri Devi, "A SURVEY ON VARIOUS APPROACHES OF TEXT EXTRACTION IN IMAGES", International Journal of Computer Science & Engineering Survey (IJCSES) Vol.3, No.4, August 2012.

[14] Samabia Tehsin, Asif Masood and Sumaira Kausar, " Survey of Region-Based Text Extraction Techniques for Efficient Indexing of Image/Video Retrieval", International Journal of Image, Graphics and Signal Processing, 2014, 12, pp 53-64

[15] Zhong, Y., Karu, K., & Jain, A. K. (1995). Locating text in complex color images. Pattern recognition, 28(10), 1523-1535.

[16] Wolf, C., & Jolion, J. M. (2004). Extraction and recognition of artificial text in multimedia documents. Formal Pattern Analysis & Applications, 6(4), 309-326.

[17] Ezaki, N., Kiyota, K., Minh, B. T., Bulacu, M., & Schomaker, L. (2005, August). Improved text-detection methods for a camera-based text reading system for blind persons. In Document Analysis and Recognition, 2005. Proceedings. Eighth International Conference on (pp. 257-261). IEEE.

[18] Hua, X. S., Chen, X. R., Wenyin, L., & Zhang, H. J. (2001, September). Automatic location of text in video frames. In Proceedings of the 2001 ACM workshops on Multimedia: multimedia information retrieval (pp. 24-27). ACM.

[19] Epshtein, B., Ofek, E., & Wexler, Y. (2010, June). Detecting text in natural scenes with stroke width transform. In Computer Vision and Pattern Recognition (CVPR), 2010 IEEE Conference on (pp. 2963-2970). IEEE.

[20] Wei, Y. C., & Lin, C. H. (2012). A robust video text detection approach using SVM. Expert Systems with Applications, 39(12), 10832-10840.

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[21] Zhao, X., Lin, K. H., Fu, Y., Hu, Y., Liu, Y., & Huang, T. S. (2011). Text from corners: a novel approach to detect text and caption in videos. Image Processing, IEEE Transactions on, 20(3), 790-799.
[22] Shivakumara, P., Phan, T. Q., & Tan, C. L. (2011). A laplacian approach to multi-oriented text detection in video. Pattern Analysis and Machine Intelligence, IEEE Transactions on, 33(2), 412-419.
[23] Ranjini, S., & Sundaresan, M. (2013). Extraction and Recognition of Text From Digital English Comic Image Using Median Filter. International Journal.

AUTHORS' PROFILES

Samabia Tehsin did her Ph.D. and M.S. in Image Processing from MCS, NUST. Currently she is working in Bahria University Islamabad as an Asst. Professor. Her areas of research are Digital Image processing, computer Vision and Document Analysis.

Sumaira Kausar is an Asst. Professor at Bahria University Islamabad. Her research interests are Digital image Processing, Gesture recognition and machine learning.

An Illustrative Approach to Use SQL Functions: A Review

Kamalinder Kaur
Assistant Professor
Chandigarh Engineering College
Punjab, India

***Abstract*—This paper describes the function used in databases for performing the calculations, modifies the data items and does manipulations on data. It defines the functions, their syntax's and errors occurred during the process. Functions are applied on oracle having SQL and are illustrated through query processing.**

Keywords- SQL; NVL; NULLIF; CASE; NVL2; DECODE.

I. Introduction

A SQL functions are brought up into oracle databases and are obtainable for its utilization in SQL queries.

II. Benefits of SQL functions

The feature of SQL is its SQL Functions. These functions perform below tasks:

1) Executing calculations on data
2) Modification of individual data elements
3) Manipulate the results for collection of rows
4) Changing date and numbers to display
5) Conversion of data types of column

III. Types of SQL Functions

Single Row Function: These functions are applied on individual rows and then gives output on single row basis. The kinds of single-row functions are:

- On Character: Accepts character input and gives back both character and number digits.
- On Number: Accepts character input and gives back both character and numerical values.
- On Date: It works on values of the DATE data type. Almost all date functions outputs a value of DATE data type butthe MONTHS_BETWEEN gives a number.
- Conversion :altersvalue from one data type to another
- COALESCE, NVL, NULLIF, CASE, NVL2, DECODE are common functions.

Character Functions

Character cases handling functions: (Lower, Initcapand Upper)

TABLE 1: Character Functions

Function	Result
LOWER('Hello Word')	hello word
UPPER('Hello Word')	HELLO WORD
INITCAP('Hello Word')	Hello Word

IV. Execution of Queries

selectename"Emp_Name",lower(ENAME)"Lower_case",upper(ename) "Upper_case", initcap(ename) "Initcap_case" from emp1 where empno in ('1','2','3','4').

```
SQL> select ename"Emp_Name", lower(ENAME) "Lower_case",
upper(ename) "Upper_case", initcap(ename) "Initcap_case"
from emp1  where empno in ('1','2','3','4')  2    3  ;

Emp_Name   Lower_case Upper_case Initcap_ca
---------- ---------- ---------- ----------
singh      singh      SINGH      Singh
preet      preet      PREET      Preet
Anderson   anderson   ANDERSON   Anderson
sachin     sachin     SACHIN     Sachin
```

Figure 1: Describing the Character functions

This can work along with where clause: Select ename"Emp_Name",upper(job) "Job", hiredate from emp1 where ename='Anderson';

```
SQL> Select ename "Emp_Name",upper(job) "Job"
  2  , hiredate from emp1 where ename='Anderson'

no rows selected
```

Figure 2: Where clause

Query with initcap,lower,upper function with where clause:

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select ename "Emp_Name", upper(job) "Job", hiredate from emp1 where initcap (ename) ='Anderson';

```
SQL> select ename "Emp_Name",upper(job) "Job",
  2  hiredate from emp1 where initcap (ename) ='Anderson';

Emp_Name   Job       HIREDATE
---------- --------- ---------
anderson   ANALYST   21-JAN-15

SQL> select ename "Emp_Name",upper(job) "Job",
  2  hiredate from emp1 where lower(ename)='anderson';

Emp_Name   Job       HIREDATE
---------- --------- ---------
anderson   ANALYST   21-JAN-15

SQL> select ename "Emp_Name",upper(job) "Job",
  2  hiredate from emp1 where upper(ename)='ANDERSON';

Emp_Name   Job       HIREDATE
---------- --------- ---------
anderson   ANALYST   21-JAN-15
```

Figure 3: Where clause in Character functions

Character-Manipulation Functions:
CONCAT: Joins the strings.
SUBSTR: Extracts the measurement lengthwise of the sub string.
LENGTH: It shows how long the string is numerically.
INSTR: helps in finding the numbered position of anyalphabet which is used.
LPAD: It justified the charactersalong the right position.
RPAD: It justified the characters along the left position.
TRIM: Itcuts thefront and last charactersoutofa string.

TABLE 2: Character –Manipulation Functions

Function	**Result**
Concat('Data' ,'Structure')	DataStructure
Substr("Data Structure",1,4)	Data
Length("Data Structure")	13
Instr('DataStructure', 'S')	5
Lpad(salary,5,'*')	**240
Rpad(salary, 5, '*')	240**
Replace('BACK and BUE','B','BL')	BLACK and BLUE
Trim('D' from 'DataStructure')	ataStructure

Selectename "Name",job "Desg.", concat(ename, job) "Concate Fun." from emp1 where empno in ('1','2','3','4');

```
SQL> select ename "Name" ,job "Desg.", concat (ename, job)
  2  "Concate Fun." from emp1 where empno in ('1','2','3','4');

Name       Desg.     Concate Fun.
---------- --------- --------------------
SINGH      MANAGER   SINGHMANAGER
PREET      CLERK     PREETCLERK
SACHIN     MANAGER   SACHINMANAGER
ANDERSON   ANALYST   ANDERSONANALYST
```

Figure 4: Concatination Function

use || symbol for cancat:
select ename "Name" ,job "Desg.", ename || ' is ' || job "Concate Fun." from emp1 where empno in ('1','2','3','4')

```
SQL> select ename "Name"
  2  ,job "Desg.", ename || ' is ' || job "Concate Fun."
  3  from emp1 where empno in ('1','2','3','4');

Name       Desg.     Concate Fun.
---------- --------- ------------------------
SINGH      MANAGER   SINGH is MANAGER
PREET      CLERK     PREET is CLERK
SACHIN     MANAGER   SACHIN is MANAGER
ANDERSON   ANALYST   ANDERSON is ANALYST
```

Figure 5: *use || symbol for cancat*

Example of Length and instr
select initcap(ename) "Name",initcap(job) "Desg.", initcap(ename) || ' is ' || initcap(job) "Concate Fun.",sal "Sal.",length(sal) "Length_sal",instr(ename,'a')"contains'a'",instr(upper(ename),'A') "contains lower 'a'"from emp1 where empno in ('1','3','4','7521')

```
SQL> select initcap(ename) "Name",initcap(job) "Desg.", initcap(ename) || ' is ' ||
  2  initcap(job) "Concate Fun.",sal "Sal.",length(sal) "Length_sal",
  3  instr(ename,'a')"contains'a'",instr(upper(ename),'A') "contains lower 'a'"
  4  from emp1 where empno in ('1','3','4','7521');

Name       Desg.     Concate Fun.                 Sal. Length_sal contains'a' contains lower 'a'
---------- --------- ---------------------- ---------- ---------- ----------- ------------------
Ward       Salesman  Ward is Salesman             1250          4           0                  2
Singh      Manager   Singh is Manager            2850          4           0                  0
Sachin     Manager   Sachin is Manager            800          3           2                  2
Anderson   Analyst   Anderson is Analyst         2500          4           0                  1
```

Figure 6: Example of Length and instr

Example of SUBSTR,LPAD,RPAD
Selectename,substr(ename,1,4),sal,lpad(sal,10,'#'),rpad(sal,10,'#')from emp1

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```
SQL> Select ename,substr(ename,1,4),sal,lpad(sal,10,'#'),
  2  rpad(sal,10,'#')from emp1;

ENAME      SUBS        SAL LPAD(SAL,1 RPAD(SAL,1
---------- ---- ---------- ---------- ----------
FORD       FORD       3000 ######3000 3000######
MILLER     MILL       1300 ######1300 1300######
SINGH      SING       2000 ######2000 2000######
PREET      PREE       5000 ######5000 5000######
Sachin     Sach        800 #######800 800#######
ANDERSON   ANDE       2500 ######2500 2500######
```

Figure 7: Example of SUBSTR,LPAD,RPAD

Example of Substr and Replace
selectename,substr(ename,1,3),replace(ename, 'a','u') from emp1 where ename like '%a%';

```
SQL> select ename,substr(ename,1,3),
  2  replace(ename, 'a','u') from emp1 where ename like '%a%';

ENAME      SUB REPLACE(EN
---------- --- ----------
Garyson    Gar Guryson
Sachin     Sac Suchin
anderson   and underson
```

Figure 8: Example of *Substr and Replace*

SQL statement displays the data for those employees whose last names end with the letter n.
Selectename,substr(ename,1,4),length(ename),instr(ename,'n') from emp1 where SUBSTR(ename, -1, 1) = 'n';

```
SQL> Select ename,substr(ename,1,4),length(ename),
  2  instr(ename,'n') from emp1 where
  3  SUBSTR(ename, -1, 1) = 'n';

ENAME      SUBS LENGTH(ENAME) INSTR(ENAME,'N')
---------- ---- ------------- ----------------
Garyson    Gary             7                7
Sachin     Sach             6                6
anderson   ande             8                2

SQL>
```

Figure 9: last names end with the letter n.

Number Functions:

TABLE 3: Number Functions

Function	Purpose
ROUND(*column*|*expression*,*n*)	This roundsoffvalues, cols and numerals upto n decimal places, if n is not included then no decimal places, if n is unsignedthenthe numerals to left position of decimal points are rounded off.
TRUNC(*column*|*expression*, *n*)	It eliminates the values to n decimal places, if n is non considerableit gives zero value.
MOD(*m*,*n*)	Gives leftovers of m by n.

Select round(45.923,2),round(45.923,1),round(45.923,-1), round(44.923,-1) from dual;

```
SQL> Select round(45.923,2),round(45.923,1),
  2  round(45.923,-1),round(44.923,-1) from dual;

ROUND(45.923,2) ROUND(45.923,1) ROUND(45.923,-1) ROUND(44.923,-1)
--------------- --------------- ---------------- ----------------
          45.92            45.9               50               40
```

Figure 10: Round function.

Select trunc(45.923,2),trunc(45.923,1),trunc(45.923,-1),trunc(44.923,-1) from dual;

```
SQL> select trunc(45.923,2),trunc(45.923,1)
  2  ,trunc(45.923,-1),trunc(44.923,-1) from dual;

TRUNC(45.923,2) TRUNC(45.923,1) TRUNC(45.923,-1) TRUNC(44.923,-1)
--------------- --------------- ---------------- ----------------
          45.92            45.9               40               40
```

Figure 11: Trunc function

selectename "Emp_Name",sal "Sal." , MOD(sal, 1000) from emp1 where empno in ('1','2','3','4');

```
SQL> select ename "Emp_Name",sal "Sal." , MOD(sal, 1000)
  2  from emp1 where empno in ('1','2','3','4');

Emp_Name         Sal. MOD(SAL,1000)
---------- ---------- -------------
SINGH            2000             0
PREET            5006             6
Sachin          10005             5
anderson         8007             7
```

Figure 12: Mod function

Operating Dates:
The Oracle recordsdates in an interiorsyntax:
Century-year-month-day-hours-minutes- seconds.
The automatic date demonstratesyntax is DD-MON-YY
selectename,hiredate from emp1;

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```
SQL> select ename,hiredate from emp1;

ENAME      HIREDATE
---------- ---------
FORD       03-DEC-08
MILLER     23-JAN-10
SINGH      10-DEC-14
PREET      15-JAN-15
Garyson    05-DEC-12
Sachin     26-JAN-16
anderson   21-JAN-15
```

Figure 13: Hire date function

HIREDATE results as DD-MON-YY. This data is stored internally as follows:

Cen	Yr	Mon	D	Hr	Min	SEC
20	12	12	17	17	10	43

Calculation on Dates

1) The resultant date value can be added or subtracted to or from a date.
2) The no. of days can be calculated between two by subtracting them.
3) Hours to a date can be calculated by dividing the number of hours by 24.

selectename "Name" ,hiredate "Hire_date",hiredate+7 "7days+hiredate" ,hiredate-7 "7days-hiredate"from emp1

```
SQL> select ename "Name" ,hiredate "Hire_date",
  2  hiredate+7 "7days+hiredate",
  3  hiredate-7 "7days-hiredate" from emp1;

Name       Hire_date 7days+hir 7days-hir
---------- --------- --------- ---------
FORD       03-DEC-08 10-DEC-08 26-NOV-08
MILLER     23-JAN-10 30-JAN-10 16-JAN-10
SINGH      10-DEC-14 17-DEC-14 03-DEC-14
PREET      15-JAN-15 22-JAN-15 08-JAN-15
Garyson    05-DEC-12 12-DEC-12 28-NOV-12
Sachin     26-JAN-16 02-FEB-16 19-JAN-16
anderson   21-JAN-15 28-JAN-15 14-JAN-15
```

Figure 14: Hire date function

selectename "Name" ,hiredate "Hire_date", round((sysdate-hiredate)/7,0)"No.ofweeks",round((sysdate-hiredate)/30,0)"No.of months",round((sysdate-hiredate)/365,0)"No.of years" from emp1.

```
SQL> select ename "Name" ,hiredate "Hire_date",
  2  round((sysdate-hiredate)/7,0)"No.ofweeks",
  3  round((sysdate-hiredate)/30,0)"No.of months",
  4  round((sysdate-hiredate)/365,0)"No .of years"
  5  from emp1;

Name       Hire_date No.ofweeks No.of months No .of years
---------- --------- ---------- ------------ ------------
FORD       03-DEC-08        376           88            7
MILLER     23-JAN-10        317           74            6
SINGH      10-DEC-14         62           15            1
PREET      15-JAN-15         57           13            1
Garyson    05-DEC-12        167           39            3
Sachin     26-JAN-16          3            1            0
anderson   21-JAN-15         56           13            1
```

Figure 13: Round on Hire date function

Features of Date:

1) Months_Between (date1, date2):
   It helps us in finding the no. of months between two dates.If date1 is afterwarddate2---output is positive; if date1 is earlier than date2, the output is negative. The non-integer portion of the output shows a segment of the month.

2) Add_Months (date, n): Add no. of months into the existing calendar date. It works only on integer values and also can be negative.

3) Next_Day(date, 'char'): Locates the next day date after the given date. It gives output in character.

4) Last_Day (date): Discovers the end date of the month while considering the given date.

5) ROUND (date [,'fmt']): Yieldsrounding of the date to specified syntax. If the syntax fmt is neglected, then date is rounded of the nearby date.

6) TRUNC (date [, 'fmt']): It yields the date after the time truncated from it. If the syntax fmt is neglected, then date is truncated to the nearby date.

Selectename,hiredate,relievingdate,round(Months_Between(relievingdate,hiredate),0)"Exp._Month",Add_Months (hiredate,,Next_Day(hiredate,'SUNDAY'),Last_Day(hiredate) from emp1;

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```
SQL> Select ename, hiredate, relievingdate,
  2  round(MONTHS_BETWEEN(relievingdate,hiredate),0)
  3  "Exp._Month",ADD_MONTHS (hiredate, 6),
  4  NEXT_DAY (hiredate,'SUNDAY'),
  5  LAST_DAY(hiredate)  from emp1;

ENAME      HIREDATE  RELIEVING Exp._Month ADD_MONTH NEXT_DAY( LAST_DAY(
---------- --------- --------- ---------- --------- --------- ---------
FORD       03-DEC-08 12-FEB-15         74 03-JUN-09 07-DEC-08 31-DEC-08
MILLER     23-JAN-10 15-FEB-16         73 23-JUL-10 24-JAN-10 31-JAN-10
SINGH      10-DEC-14 31-DEC-15         13 10-JUN-15 14-DEC-14 31-DEC-14
PREET      15-JAN-15 31-JAN-16         13 15-JUL-15 18-JAN-15 31-JAN-15
Garyson    05-DEC-12 05-JUL-13          7 05-JUN-13 09-DEC-12 31-DEC-12
Sachin     26-JAN-15 25-JAN-16         12 26-JUL-15 01-FEB-15 31-JAN-15
anderson   21-JAN-12 21-JAN-16         48 21-JUL-12 22-JAN-12 31-JAN-12
```

Figure 14: date function

In Where Clause
Selectename,hiredate,relievingdate,round(Months_Between (relievingdate,hiredate),0) "Exp._Month" from emp1
WhereMonths_Between (relievingdate,hiredate) >=12

```
SQL> Select ename,hiredate,relievingdate,
  2  round(MONTHS_BETWEEN (relievingdate,hiredate),0)
  3  "Exp._Month" from emp1
  4  where MONTHS_BETWEEN (relievingdate,hiredate) >=12;

ENAME      HIREDATE  RELIEVING Exp._Month
---------- --------- --------- ----------
FORD       03-DEC-08 12-FEB-15         74
MILLER     23-JAN-10 15-FEB-16         73
SINGH      10-DEC-14 31-DEC-15         13
PREET      15-JAN-15 31-JAN-16         13
anderson   21-JAN-12 21-JAN-16         48
```

Figure 15: Hire date function with where clause

Round and Truncate Function with Dates
Select ename, hiredate, ROUND(hiredate,'MONTH'), TRUNC(hiredate,'MONTH'), ROUND(hiredate,'YEAR'), TRUNC(hiredate,'YEAR'), ROUND(hiredate,'DAY'), TRUNC(hiredate,'DAY') FROM EMP1;

```
SQL> Select ename, hiredate, ROUND(hiredate,'MONTH'),
  2  TRUNC(hiredate,'MONTH'), ROUND(hiredate,'YEAR'),
  3  TRUNC(hiredate,'YEAR'), ROUND(hiredate,'DAY'),
  4  TRUNC(hiredate,'DAY') FROM EMP1;

ENAME      HIREDATE  ROUND(HIR TRUNC(HIR ROUND(HIR TRUNC(HIR ROUND(HIR TRUNC(HIR
---------- --------- --------- --------- --------- --------- --------- ---------
FORD       03-DEC-08 01-DEC-08 01-DEC-08 01-JAN-09 01-JAN-08 30-NOV-08 30-NOV-08
MILLER     23-JAN-10 01-FEB-10 01-JAN-10 01-JAN-10 01-JAN-10 24-JAN-10 17-JAN-10
SINGH      10-DEC-14 01-DEC-14 01-DEC-14 01-JAN-15 01-JAN-14 07-DEC-14 07-DEC-14
PREET      15-JAN-15 01-JAN-15 01-JAN-15 01-JAN-15 01-JAN-15 18-JAN-15 11-JAN-15
Garyson    05-DEC-12 01-DEC-12 01-DEC-12 01-JAN-13 01-JAN-12 02-DEC-12 02-DEC-12
Sachin     26-JAN-15 01-FEB-15 01-JAN-15 01-JAN-15 01-JAN-15 25-JAN-15 25-JAN-15
anderson   21-JAN-12 01-FEB-12 01-JAN-12 01-JAN-12 01-JAN-12 22-JAN-12 15-JAN-12
```

Figure 16:Round and Truncate on date

Conversion Functions

If Oracle server needs to convert one data type to the other then it can repeatedly .Converts the data to expected data type. The expected data type by the Oracle server conversion can occur wholly and clearly by the user. For this purpose some functions are required to forcefully convert the data casting to another known as conversion functions. The function names follow the conventional input data type TO output data type.

1) Conversion Type: Implicit Data Type

CHAR, VARCHAR2 can be wholly changed to NUMBER or DATE. NUMBER type value can be routinely converted to character data by Oracle server. It occurs only when the character signifies a valid number or date type value correspondingly.

For example : the select queries outputs same because Oracle inside allows 1000 and '1000' as same.
Query-1
SELECT ENAME,JOB,SAL
FROM EMP1
WHERE SAL >15000;
Query-2
SELECT ENAME,JOB,SAL
FROM EMP1
WHERE SAL > '15000';

2) Conversion: Explicit Data Type

These functions are for single row which are skillful of converting column value, literal or an expression.
TO_DATE
TO_NUMBER
TO_CHAR

3) Function: TO_CHAR

It is required to cast a numeric input value to character type using a fixed model.

Format:
TO_CHAR(num1,[format],[nls_parameter])
Think about the below SELECT query. The query syntax the HIRE_DATE and SALARY columns of EMPLOYEES table using TO_CHAR ().

SELECT ENAME,TO_CHAR (hiredate, 'MONTH DD, YYYY') HIREDATE,TO_CHAR (sal, '$99999.99') Salary FROM emp1

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Figure 17: To-char function

TABLE 4: To-char function

Syntax Model	Explanation
,(comma)	This allots the position to a comma. Many no. of commas can be particularlyin a number syntax model. Boundaries: a number syntax model cannot begin by comma element and it cannot comeat the right arrangementof a decimal character or period.
.(period)	It gives the definite position. Boundaries:Itindicates only one function in a number layout model
$	Yieldsassessmentwith dollar sign.
0	It begins with zeros and proceedswith zeros at end.
	positive-gives value with the describednumber of digits with space in frontand negative with a minus sign in front.

5) Function:TO_NUMBER

Itconverts a numeric datatype from a character datatype.

Syntax:
TO_NUMBER(string1,[format],[nls_parameter])
list of layout models which can be used to typecast character values as number using TO_NUMBER.

Layout Model	Explanation
CC	Denotes Century
SCC	It gives Century Before Christstarted with -
YYYY	It displays year havingfour numbers
SYYY	It gives year before Christ with-prefixed with -
IYYY	Gives ISO Year havingfour numbers
YY	It is Year having 2 digits
YEAR	Gives Year in alphabets
SYEAR	Yields Year in alphabets, BC prefixed with -
MONTH	Gives Month in alphabets(i.e. January)
MON	Results JAN, FEB
WW	Gives Week number (i.e. 1)
W	Gives Week digit of the month (i.e. 5)
IW	Gives Week digit of the year in ISO standard.
DDD	Results Day of years in numbers (i.e. 365)
DD	Results month day in values (i.e. 28)
D	Gives week day in numbers(i.e. 7)
DAY	Gives Day of the week in alphabets (i.e. Monday)
FMDAY	Gives Day of the week in characters (i.e. Monday)
DY	Results Day of the week in short character description (i.e. SUN)
J	It Yields Julian Day
HH,H12	Gives Hour number of the day (1-12)
AM, PM	Gives AM or PM
MI, SS	Denotes Number of minutes and seconds (i.e. 59) ,
SSSSS	Gives seconds number of day.
DL	Results Long date format. Depends on NLS-settings. Use only with timestamp.
EE	Gives the full period name
FF	Gives the fractional seconds. Use with timestamp.
FF1..FF9	Gives the fractional seconds. Use with timestamp.
FM	It Fill Mode.
FX	It Format Exact: requires proper pattern matching between date and layout model.
RM	Returns The Roman cipherfor month (I .. XII)
RR	Returns The last 2 digits of the year.
RRRR	Returns The last 2 digits of the year when used for output. Accepts fout-digit years when used for input.
TH	It Converts a integer to it's ordinal layout. For example 1 becomes 1st.
TS	Gives Short time format. Depends on NLS-settings. Use only with timestamp.
TZD	It is reduced time zone name. ie PST.
TZR	Denotes Time zone region
X	It Denotes Local radix character. It is a period (.) in America

The SELECT queries written beneathallow numbers as alphabet intake.

SELECT TO_NUMBER('12,100.73', '999999.99') FROM DUAL;

2) Function:TO_DATE

This acceptsalphabet values as intake and outputs theplanned date. The TO_DATE function permits users to use a date in any layout, and then it reverts the input into the default layout used by Oracle 11g.
Syntax:
TO_DATE(string1, [format_mask], [nls_language])

TABLE 5: To-date function

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Layout Model	Explanation
YEAR	It spelled outYear
YYYY	Gives 4-digit year
IYY,IY,I	Gives Last 3, 2, or 1 digit(s) of ISO year.
IYYY	Four -digit year based on the ISO standard
Q	It gives Quarter of year (1, 2, 3, 4; JAN-MAR = 1).
MM	Returns Month (01-12; JAN = 01).
MON	Gives name of month.
MONTH	Results Name of month, covering with blanksupto 9 characters.
RM	Gives Roman numerals for month starting from I-IX.
WW	Returns Week of year (1-53)
W	Gives Week of month (1-5)
IW	On the basis of ISO standard week of year is 1-52or1-53
D	Returns the week day.
DAY	Gives Name of day of week.
DD	Gives month day (1-31).
DDD	Gives year day (1-366).
DY	name of day is abbreviated
J	Returns Julian day;
HH12	Gives day hours (1-12).
HH24	Gives day hour(0-23).
MI,SS	Gives Minute (0-59).
FF	Returns seconds in fraction.
AM,PM	Gives indicator Prime Meridian
TZH,TZM,TZR	Results Time zone in hour, minute.

Example: a character string transforms into a date syntax.
SELECT TO_DATE('February 15, 1970, 11:00 A.M.', 'Month dd, YYYY, HH:MI A.M.', 'NLS_DATE_LANGUAGE = American')
FROM DUAL;

TO_DATE(15-FEB-70)

Common Functions
These are used to holdvoid values in database. The purpose of the common NULL controlling function is to swap the void values with a substitute value.

NVL
The NVL -deputies another value for a void value. NVL function can be used with all kinds of data types.

Syntax:
NVL(Arg1, replace_with)

This case includesboth the constraintswhich are mandatory.

The SELECT statement will display 'n/a' if an employee has not been assigned any job yet i.e. JOB_ID is NULL. Else, it would exhibit the actual JOB_ID value.

SELECT first_name, NVL(JOB_ID, 'n/a')
FROM employees;

NVL2
It is an improvement over the earlier NVL,Oracle presented a facility to standby data not only for NULL columns values but also for NOT NULL columns. NVL2 can be used an alternate for Null (Void) and also for non-null value.
Syntax:

NVL2(string1, value_if_NOT_null, value_if_null)

The SELECT statement under would display 'all' if the JOB_CODE for an employee is NULL. Finally, not null value of JOB CODE, it would rather display constant value 'Job done'.
SQL> SELECT NVL2(all, 'Job done', 'Bench')FROM employees;

NULLIF
The NULLIF is related to two arguments expr1 and expr2. If expr1 equals to expr2 then it gives NULL otherwise expr1. Dissimilar to it first parameter cannot be void.

Syntax:
NULLIF (expr1, expr2)
In this the first parameter can be nearer to NULL, but not as NULL. Both the constraints are compulsory for its execution.

The under query yields NULL until values, 16 are equal to each other.

Select NULLIF (16, 16) from dual;

Also, under query yields ‘ABC’ since both the strings are not equal.

SELECT NULLIF ('ABC', 'MOON')FROM DUAL;

COALESCE
It is basic form of NVL that gives the first non-void phrase in the parameter list. It requires minimum two parameters but there is no limit on its maximum limit.

Syntax:
COALESCE (stmt1, stmt2, ...stmt_n)
Considering the SELECT query. The first not null data served into address domain for the employee.

SELECT COALESCE (address1, address2, address3) Address FROM employees;

The functioning of coalesce function is like to IF..ELSIF..ENDIF construct.

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```
IF address1 =!NULLthen
result := address1;
ELSIF address2 =!null THEN
result := address2;
ELSIF address3 =!null THEN
result := address3;
ELSE
result := null;
END IF;
```

Functions: Conditional

Two functions DECODE and CASE are used in SQL statement.

1. DECODE function:

The function is similar to conditional statement IF..THEN..ELSE .

Syntax:

DECODE (exp, srch, output [, search, result]... [, default])

DECODE checks in sequence. If equality occurs between statement and search parameter, and it yields the conforming result. If no matches occurs then null is defined. In case types mismatch then oracle within does likely inbuilt alteration to yield the results.Oracle says two null values can be same in case of decode function.

```
SELECT DECODE(NULL,NULL,'EQUAL','NOT EQUAL')
FROM DUAL;

DECODE
-----
EQUAL
```

If NULL expression is found, then Oracle returns output of first search as null. The No. of components are 255.

```
Select first_name, salary, DECODE (hire_date,
sysdate,'NEW JOINEE','EMPLOYEE') FROM employees;
```

CASE expression

Its mechanism logically similar to DECODE but varies in format and utilization.

Syntax:

```
CASE [ expression ]
When 1_condition … result_1
When 2_condition … result_2
……..
 When n_condition … result_n
  ELSE output
END
```

The determined number of parameters in a CASE expression are 255. Each WHEN ... THEN pair calculates as two arguments. To evade exceeding the limit, nested CASE expressions can be used so that the output_exp itself is a CASE expression.

```
Select first_name, CASE          when salary < 100 THEN
'GRADE 1'
                    when salary > 100 AND salary <
4000 then 'GRADE 2'
                    ELSE 'GRADE 3'
                END CASE
From employees;
ENAM          CASE
----   -------
Admin   GRADE 2
Jass   GRADE 3
Kumar    GRADE 1
```

V. Conclusion

The Query processing of SQL functions comprises of conversion functions has done in this paper .This showed the data manipulation ,formatting, general functions, conditional functioning and its transformation from inbuilt to forceful conversion. In future the work can be done on multiple row functions also.

References

[1] Groff and Weinberg, "SQL-The Complete Reference

[2] Ivan Bayross, "SQL, PL/SQL-The Programming Language of Oracle.

[3] Koch and KelvinLoney,"Oracle 9i- Complete Reference".S

[4] Korth, "Database System Concepts".

[5] https://docs.oracle.com/cd/B19306_01/server.102/b14200/functions001.htm.

[6] https://msdn.microsoft.com/enus/library/gg415714.aspx.

[7] http://www.oracle.com/technetwork/database/bi-datawarehousing/wp-sqlnaturallanguageanalysis-2431343.pdf.

[8] https://ocw.mit.edu/courses/urban-studies-and-planning/11-521-spatial-database-management-and-advanced-geographic-information-systems-spring-2003/lecture-notes/lect4.pdf.

[9] Jean Habimana," Query Optimization Techniques - Tips For Writing Efficient And Faster SQL Queries " International Journal of Scientific & Technology Research volume 4, issue 10, october 2015 issn 2277-8616 22 ijstr©2015 .

[10] Swati Jain and Paras NathBarwa," Performance Analysis of Optimization Techniques for SQL Multi Query Expressions Over Text Databases in RDBMS ",International Journal of Information & Computation Technology. ISSN 0974-2239 Volume 4, Number 8 (2014), pp. 841-852.

[11] MJ Egenhofer,"Spatial SQL: A query and presentation language" IEEE Transactions on knowledge and data engineering 6 (1), 86-95.

[12] Max J Egenhofer,"Query processing in spatial-query-by-sketch" in Journal of Visual Languages &Computing ,in volume 8and issue 4.

[13] J.Herring,R.Larsen and J.Shivakumar, "Extensions to the SQL Language to support Spatial analysis in a Topological Database" ,GIS/LIS 88,San Antonio,TX,1988,pp.741-750

[14] M.Egenhofer, "why not SQL!",International Journal of Geographiccal Information Systems ,vo.6,no.2,pp.71-85,1992.

ISBN: 978-0-9957075-4-2 *DOI: 10.24032/ijeacs/0203/05*

[15] M.Jones, "An introduction to Gofer", Department of Computer Science,YalleUniversity,Technical report,1991.

AUTHOR PROFILE

Kamalinder Kaur is working currently as Assistant Professor in Chandigarh Engineering College, Punjab, India. She has five years of teaching experience, her research interest includes Networking with specialization in Mobile Ad-hoc Network (MANET).

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