# Rule Based Exception Handling and Priority Modeling For Diabetes Management Using Ontology and SWRL

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**Abstract- Increase treatment quality is the most challenging task because clinical status of the patient and circumstances inside a healthcare organization constantly change. In this paper we present a Rule based Exception handling and Priority modeling (REP) framework which aims at providing a solution for diabetes management. However, this functionality is a major requirement for next generation systems in order to deal with more exceptions at a time. The proposed framework explains about how to manage resources and activities during diabetes management. The exceptions are detected with the help of rule interpreter and rule base. The hospital workflow system is assisted by the semantic technologies, which utilize ontology to describe the required knowledge. At the time of monitoring, if any exceptions arise, the system reasons over the constructed Semantic Web Rule Language (SWRL) rules and provide decisions for the next step of the treatment. In order to provide treatment flow for the known cases, the adaptation results and patient information are stored on Electronic health record**.

**Keywords- Rule engine, exception detection, ontology, priority modeling**

## I. INTRODUCTION

Diabetes is the main disease that increases glucose level in blood. It is becoming the more common disease in India as well as in other developing countries in Asia [1]. Increase treatment quality and reduce domain experts cost and time is the focusing issue in healthcare decision support system. In order to achieve their goal they need a standardized protocol for continuous monitoring. Such protocols contain detailed medical plans for diagnosis, therapy scheme and follow up. Additionally, it contains all the needed scientific information's to deal with exceptions, which occur during execution. Healthcare systems involve multidisciplinary resources like personnel, education level, medical equipment availability and other operational information. In this research work a framework for exception handling and priority modeling for diabetes management is presented, which includes a hospital work flow engine with a Rule interpreter to detect the exceptions that arise during execution. The interpretation whether or not an event constitutes a medical exception is the task of a Rule Base (RB).

The rest of the paper is organized as follows; section 2 refers to related work performed in the area of our interest section 3 overviews the technical architecture which is being implemented. Section 4 provides the performance evaluation results and Section 5 concludes the paper combined with our thoughts for future work.

## II. MATERIALS AND METHODS

This study [2] presents a sempath prototype to achieve real-time adaptation of healthcare. This prototype consists of rule set execution. After the execution of the rule set, the next step of the treatment is defined. But the protocol does not provide priority modeling for resources and activity management. The protocol does not deal with simultaneous clinical path execution.

As [3] provides a Semi Automated HER (SA-EHR) that explain about how to record the medically significant events during surgery in a real-time environment with the use of stream processing engine. The system also use radio frequency identification to identify the medicines used during surgery. But the system cannot account the time to carried out the medical event. The system does not deal with supply tracking and there is no video clip of the surgery in order to the physicians to evaluate their skills.

This work [4] develop a protocol in an distributed environment that provides continuity of care by using control numbers and explain about the requirements needed for locating and accessing clinical records

across country borders in association with data protection. But if universal accepted standards arise in the future it possibly render the protocol so how long it can be applied is not yet known.

## III. TECHNICAL ARCHITECTURE

The technical architecture of the system is presented in figure 1.It consists of Three major environments. These three environments are described in full detail in the following sections.

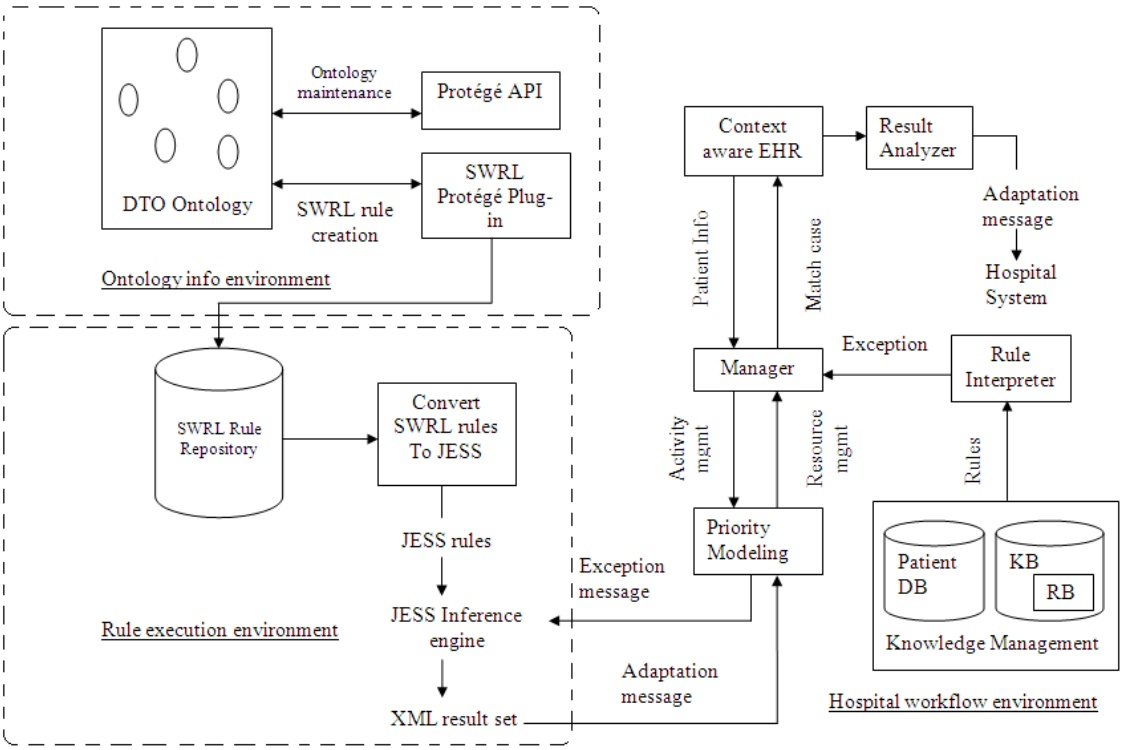


Figure 1 Technical architecture of the framework

### A. Hospital workflow environment

It contains workflow part of the organization. The HR monitor, ECG and Blood oxygen monitor are enclosed in hospital system. From that the Knowledge Base (KB) incorporating RB consists of patient independent information about medical events.

**Exception detection**

The exceptions are detected with the use of knowledge manager. The KB contains the set of normal range values for each instances related to diabetes diagnosis such as plasma glucose level , blood pressure, skin fold thickness, body mass index, age etc. The knowledge is converted to rules with the help of knowledge manager and the developed rules are stored in RB. The Rule Interpreter (RI) work with KB, RB and patient database, it indicates whether exception arises or not. There are three main events were identified, which produce exception. Medical events (laboratory or side effects due to drug), organizational events (resource conflicts) and social events (loss of patient compliance for the treatment). The RI indicates the exception arises and which type of event under what condition it arise.

Patient:[Id=>Integer, diagnosis=>string, normal value=>string,

obvalue1, obvalue2, obvalue3=> string]

exception:[evtype{medical ,organizational ,social}=>string]

The manager acts as an interface between workflow engine and rest of the environments. When exception occurs, the exception message is passed to Electronic Health Records (EHR) for match case and retrieves patient information. If match found the result is adapted to the workflow engine via Result analyzer. Otherwise the Range value is used to set the priority for each activity, and then the exception message is passed to rule engine with its priority. The result of the rule engine is also stored in EHR and adapted to hospital workflow engine via Result Analyzer (RA). It encloses Context aware EHR .The term context aware is a general concept that refers to the capability of a system to aware of its physical and logical environment and to intelligently react according to the application domain and related purposes. Here the EHR has been used to maintain patient details.

**Priority modeling**

Three consecutive values related to diabetes diagnosis are retrieved. From these values the monitoring algorithm used to determine rate of change. The rate of change of data is determined by comparing consecutive average values gives us a good estimate of the rate of change of values, it can be of the terms little increase, sudden increase, steady increase, little decrease, sudden decrease, steady decrease. With respect to these values the activities are scheduled. That is, the highest priority is executed first. In resource management, it encloses the First Come First Served (FCFS) algorithm to adapt results in the hospital workflow engine. Table 1 describes the functionality of priority modeling based on single instance plasma glucose level.

### B. Rule execution environment

This environment deals with the maintenance of the SWRL rules and the rule engine were implemented. The SWRL rules implemented with the SWRL plug-in and the rules are stored into a SWRL repository. When the system is triggered, the corresponding rule set is selected. Figure 2 describes the SWRL rule editor with an example rule. The rule provides treatment flow and follow-up messages for a particular patient suffered by Type 1 diabetes.

Table 1:

| Patient Id | Date and time of arrival | Diagnosis PLASMA GLUCOSE | | | Rate of change | priority |
|---|---|---|---|---|---|---|
| | | O1 | O2 | O3 | | |
| 123 | 10.2.10 8.00am | 200 | 200 | 202 | Constant increase | 1 |
| 124 | 10.2.10 8.00 am | 200 | 220 | 240 | Sudden increase | 2 |

Table 1 for priority modeling based on single instance.

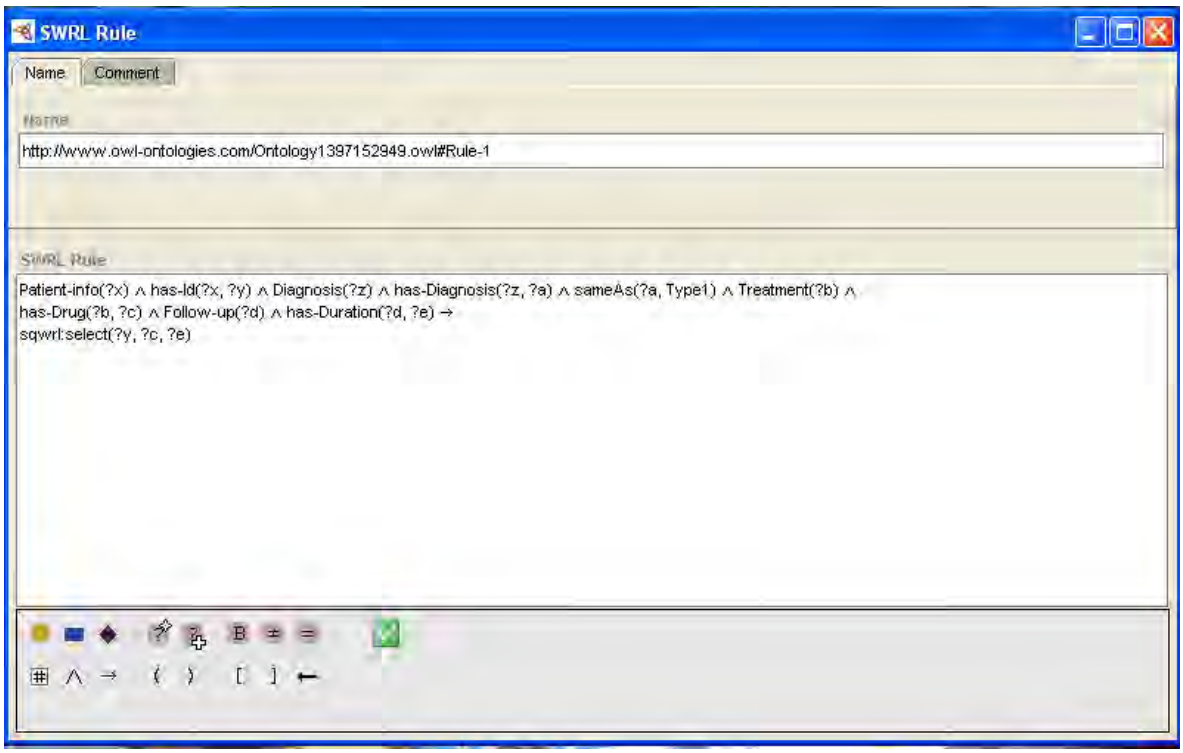


Figure 2 SWRL rule example for patients with Type1 diabetes

The SWRL rules are converted to Java Expert System Shell (JESS) rule, for the purpose of execution by JESS rule engine [8]. After the execution of the rule engine, the result is produced in XML format. It constitutes the rule execution layer and it encloses the components required for the adaptation. The rule engine is responsible for the execution of the semantic rules concerning the exception handling. The corresponding rule set is executed and results are converted to XML format for adaptation.

The adaptation message is passed to manager and stores it in EHR.

Patient:[ Id=>integer, diagnosis=>string,

Range of value=>{constant, sudden increase}=> string]

exception:[evtype{medical, organizational ,social}=>string]

physician:[name=>string, drug=>string, follow- up value=>string]

### C. Ontology info environment

The core of ontology info environment is the Diabetes Treatment Ontology (DTO). The ontology is implemented in Web Ontology Language (OWL) format [5]. Protégé API is used for implementation and maintenance of the specific ontology.

It encloses the appropriate knowledge streams required for the modeling of the system in terms of structure and content, it also encloses the semantic modeling of the rules that handle the exceptions inside the system. The ontology is an electronic representation of the patient records and various health related information. The medical ontology is based on [6] and [7] and represents conceptual knowledge about the clinical situation from clinical problems, investigations and recommendations. The part of the constructed DTO ontology is represented in figure 3.

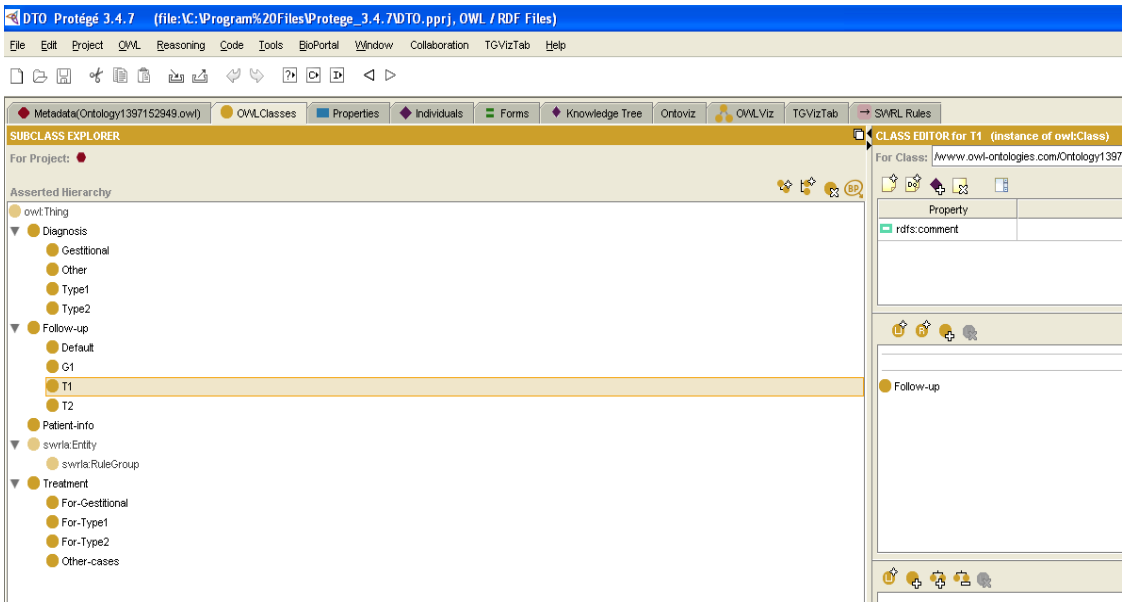


Figure 3 partial design of the DTO ontology in protégé

## IV. RESULTS AND DISCUSSION

The constructed model for diabetes management was implemented with Java 1.6.0 and Protégé 3.4.7. The experimental study was conducted to prove the efficiency of the model by comparing the proposed model with the existing model SA-EHR. In figure 4 we measure the time to detect the exceptions. This figure concludes if the numbers of exceptions increases, the corresponding time to detect the exceptions are gradually decreases. It assures the proposed model has an efficient learning facility.

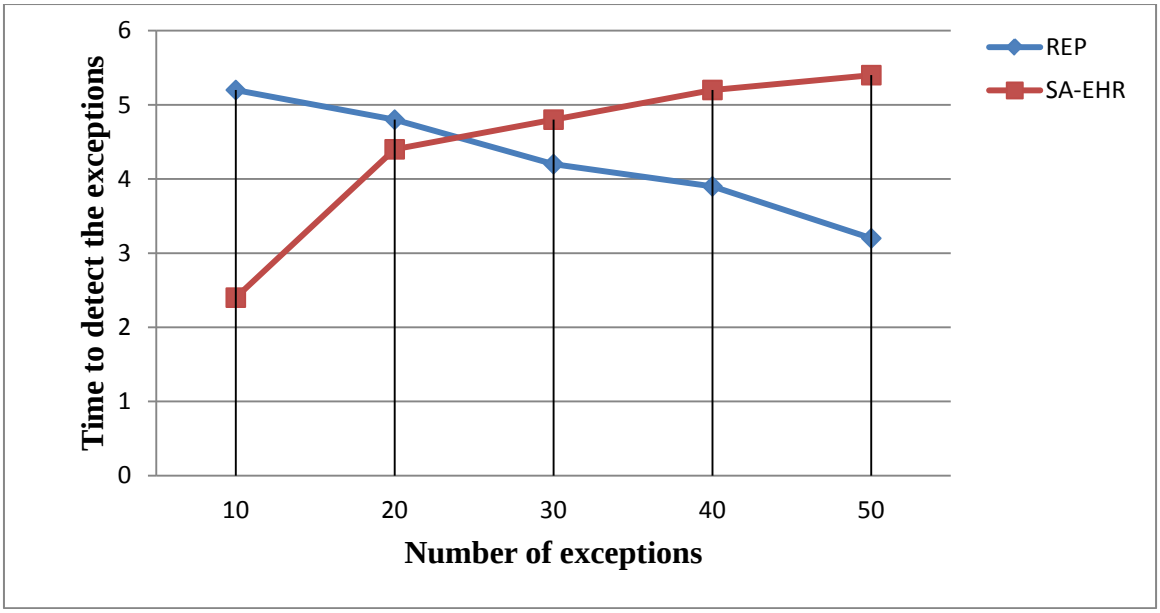


Figure 4 Number of exceptions Vs Time to detect the exceptions.

By the utilization of EHR, the execution time of the model is reduced. That is, if the patient arrives with the same known case, the framework need not execute the rule execution and ontology info environments instead the EHR provides the treatment flow based on the retrieved case.

## V. CONCLUSION

The system is very useful for monitoring patient state, handling exceptions and deals with priority modeling that is manage activities and resource management. A significant amount of work has been done in the area of ontology creation. The developed ontologies cover several streams of medical knowledge. It introduces the creation of semantic rules in SWRL format which provide the basis for the rule-engine that provides the treatment flow. Fusing the semantic web with the real world is creating a niche of innovative approaches to further enhance existing solutions to real life situations. In order to make the framework as more efficient, our future work comprises i) ontology enhancement and integrate with existing medical guidelines. ii) Manage simultaneous execution of rules on JESS.

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