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Stream-based Reasoning for IoT Applications on Domain Education

Marcelo ALVES JÚNIOR[a*], Francisco SILVA[b] , Markus ENDLER[c], Vitor ALMEIDA[c] & Higo SAMPAIO[d]
[a]*Dept. of Informatics, Federal Institute of Maranhão, Brazil*
[b]*LSDi, Univ. Federal do Maranhão, Brazil*
[c]*Dept of Informatics, PUC-Rio, Brazil*
[d]*Federal Institute of Maranhão, Brazil*
*marcelo.alvesjunior@ifma.edu.br

Abstract: As the complexity of distributed Internet of Things (IoT) applications increases, so does the need for better processing of raw data flow of sensors. And since many IoT applications require almost real-time reactivity to the environmental stimulus, such information inference process must be performed continuously and on-line. This paper proposes a semantic model of data flow processing and real-time reasoning based on Semantic Stream concepts as a natural extension of the Complex Events Processing (CEP) and RDF (graph-based knowledge model). In this paper, we describe a scenario about patients flux monitoring in a clinic dental school. Finally, we will present perspectives and prospects on the new way of storage the Semantics Stream and finish the development of the Semantic Event Rules using ESPER EPL (Event Processing Language).

Keywords: Internet of Things (IoT); sensors; data streams; complex event processing (CEP); semantic reasoning

1. Introduction

With the expansion of the use of IoT applications using CEP (Complex Event Processing), the need to extend the processing of raw data arriving through sensors has arisen in the same proportion. These applications are demanded in various domains, including education. To generate an information or generate an action, it is necessary that this data can be treated in a more complex way than the common processing. Therefore, in order to improve this data processing, this process has been enriched semantically. The inclusion and storage of triple Resource Description Framework (RDF), provides a semantic enrichment of complex event processing (Adi, Botzera and Etzion, 2000). This semantic model enables the discovery of facts that were not possible to be extracted with simple processing Teymourian, Rohde and Paschke, 2012). This article proposes the application of semantically enriched CEP rules to generate simple scalable actions.

With the goal of finding a suitable semantic model for IoT, this paper proposes a approach for real-time symbolic reasoning based on the concepts of Semantic Stream and Fact Stream, as natural extensions of Complex Event Processing (CEP) (Luckham, 2001) and RDF (graph-based knowledge model) (Candan, Liu and Suvarna, 2001). This article presents a general idea of IoT in the second chapter, a scenario of health education in the third, and finally, in the fourth chapter, the conclusion and future work of the proposal.

2. General Idea

Our proposal is to define a CEP transformation, through a semantic flow of events, in order to create information of a higher level, that is, semantically enriched information. The proposal foresees generation of RDF triples, from pre-processed events. Thus, it is possible to merge these triples and generate what we call the flow of facts. With this, we can detect the type of entity and if an action was generated by it. The identification of entities and predicate identification is performed by the CEP agent next to the sensors, (see Figure 1), which in the specific case of our IoT middleware usually runs on mobile devices. Therefore, we call them Mobile Event Processing Agents (EPAs). In Figure 1, it can be seen that through these agents, mentioned above, two of the three RDF triple data can be generated.

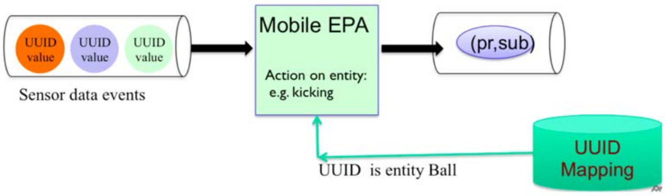

Figure 1. Semantic annotation from raw sensor data.

3. Scenario

Considering a clinical school dentistry environment in which several patients are targeted to a group of students. A common problem is that patients do not have adequate and continuous treatment., in addition to waiting to know if it is being referred. A general organization of patient flow is presented in Figure 2.

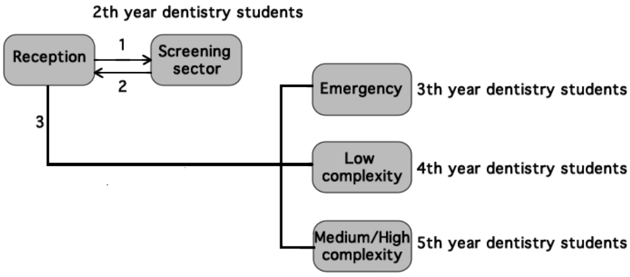

Figure 2. Organization of the Dentistry school clinic.

The reception is the first place where the patient will be register. Then he is sent to the screening sector, this sector is composed of an advisor along with the students of the second year of the course of dentistry. Later, upon detection of the problem, the student informs the reception of the current patient case and where it should be routed. Therefore, the responsibility to arrange the consultation with students who are in later periods, is with the reception. Depending on the diagnosis, the patient can be referred to the following sectors: *i)*Emergency (3th year dentistry students): Acute pain and e dental extrusion; *ii)*Low complexity (4th year dentistry students): Restorations and scraping; and *iii)*Medium/High complexity (5th year dentistry students): prosthesis and endodontics.

3.1 Assumptions

To facilitate the understanding of our example, let us divide the explain up into two parts. Our goal here is to identify bottlenecks with the following characteristics: *i)*The patient spends a lot of time in the waiting queue; *ii)* Some students do not appear on the scheduled appointment day and *iii)* The patient is left unattended because he can not be relocated to another student who is available.

To infer these complex events, we can make some hypotheses: *i)* The patient and the student will have a mobile device in which an ID will be associated with identification; *ii)*The student will be allocated according to time in the course, that is, second, third, fourth or fifth year; *iii)* Each room will have a BLE sensor to identify how many and which students are present in the clinic; *iv)* Every patient chair will have a BLE sensor to identify whether it is occupied or not; *v)* The screening sector will have a BLE sensor to identify patients' arrival and departure flow.

3.2 Proposal

From the above premises, we can elaborate a CEP strategy for solving our problem. The sensors present at the reception will detect the arrival flow of the patients who are already previously associated with the students in charge of their cases. In addition to this, the system will be able to detect if the student in question is present. If the student is not present, the system will be able to relocate the patient to a new student at run time. Our proposal becomes clearer in Figure 3, where there is a flow of triple RDFs with CEP rules that are processed and stored in a knowledge base. This base is responsible for storing RDF triples in order to provide facts through the processing of Semantics streams.

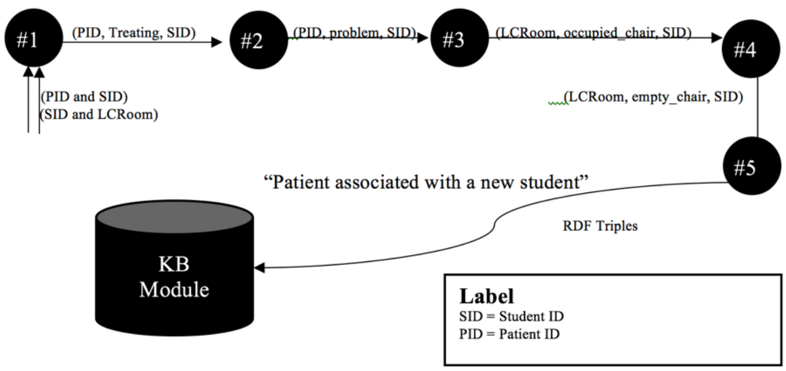

Figure 3. CEP nodes and information flow.

4. Conclusion and Future Works

This paper presented a real-time reasoning approach based on semantic events for IoT applications. The proposal takes into account a scenario in which all objects, people, places, environments, etc. there are sensors in order to emit simple events whenever some action is performed to or with it by an actor and that each event will take UUID exclusive of the items and the precise time that has occurred. Restricting the predicates in a triple RDF in action how to get to, associate, attend, etc., rather than state, such as has, is, belongs to, etc., is limited the amount of information that flows Data / Events can express. However, it is believed that if we base all predicates on action we will raise the importance of reasoning in IoT applications. The next steps, we will finish the development of the Semantic Event Rules using ESPER EPL (Event Processing Language) and deploy them on our mobile IoT middleware.

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References

Adi, A. Botzera, D. and Etzion, O. Semantic Event Model and its Implication on Situation Detection. In European Conference on Information Systems (ECIS 2000), 2000.

Candan. K. S. and Liu. H. and Suvarna. R. "Resource description framework: Metadata and its applications," SIGKDD Explor. Newsl., vol.3, no. 1, pp. 6–19, Jul. 2001. [Online]. Available: http://doi.acm.org/10.1145/507533.507536

Luckham. D. C. The Power of Events: An Introduction to Complex Event Processing in Distributed Enterprise Systems. Boston, MA, USA: Addison-Wesley Longman Publishing Co., Inc., 2001.

Teymourian, K. Rohde, M. and Paschke, A. "Fusion of background knowledge and streams of events," in 6th ACM International Conference on Distributed Event-Based Systems, ser. DEBS'12. ACM, 2012, pp. 302–313