International Journal of Computing Academic Research (IJCAR)
ISSN 2305-9184, Volume 6, Number 4 (August 2017), pp.118-124

http://www.meacse.org/ijcar

Internet of Things: A rule-based analysis applied to a ubiquitous healthcare system

Reda CHEFIRA and Said RAKRAK

LAMAI, Faculty of Sciences and Techniques (FSTG), Cadi Ayyad University (UCAM) Marrakesh, Morocco

Abstract

This paper proposes a rule-based approach applied on a ubiquitous healthcare system, helping medical staff to diagnose health seizures by generating, analyzing and classifying patient's medical rules using multiple data mining approaches such as A priori, FP-growth algorithms. A comparison of the used algorithms is depicted in the following chapters.

Keywords: Healthcare; Internet of Things; Datamining; Wirless Body Area Networks

Introduction

Wireless Body Area Network (WBAN) is a forthcoming technology closely related to Wireless sensor networks, which interconnects devices all around a body. This smart technology is fastening many fields such as health, gaming and sports. Due to its polyvalent roles, many tiny electronic connected devices offer a research horizon capable of resolving several issues, especially in the internet of things such as healthcare, smart buildings, edge computing and so on. Ascribable to their performance for designing and implementing complex wireless sensor network architectures, multi agent systems can be used to face wsn's limitations such as resources, topologies, sensed data computation, and so on. Nowadays, mani fields are connected to the internet of tings viz. Healthcare[1], military[2] and entertainment[3]. Wireless body area networks are a variety of wireless sensor networks that can interconnect with internet of things. PHY and MAC[4] protocols are used simultaneously with existing WPAN standards. The most used topologies in WBANs are the Zigbee 802.15.4 and the BAN 802.15.6 standards[5]. Despite the continuous research and development efforts from both industry and researchers, wireless sensor networks face many problems such as network topologies, power consumption and limited resources[6]. Therefore, the reminder of this paper is organized as: After this introduction, section 2 represents the related works done in the field of rule based approaches applied to wireless body area networks using datamining process. Setion 3 deals with the wireless body area networks main application such as medical, sports and so on. Section 4 represents the IEEE 802.15 wireless personal area networks and the most used standards. Section 5 is designing the wban architecture with the sensors gathering vital data of a patient's body. It explains also a comparison of two datamining algorithms Apriori and FP-growth. Current work has been concluded in Section 6.

Related works

Apriori algorithm is used to predict the occurrence of diabetes and identify the yet its undiscovered decision factors which increases the possibility of making better decisions identifying disease complication. In order to optimize the approach execution, frequent pattern tree structure can also be used to avoid expensive scanning of database. In [8] A new method is presented to find the utility of association rule mining applied on multiple diseases like breast cancer, mushroom, larynx cancer. Apriori, PredictiveApriori and Tertius Algorithms are employed to discuss different case studies. In [9] authors presented a new multi-agent based approach applied on a ubiquitous healthcare system in order to diagnose and prevent health seizures. The used algorithm is Apriori and the results are directly communicated to medical staff to enrich the detection process. A health care monitoring system design capable of collecting, retrieving, storing and analyzing the vital signs of a patient such as blood pressure, pulse and respiratory rates is also presented in[10]. The proposed MAS architecture is capable of managing many processes and reduces data traffic queries.

Wireless Body Area Networks applications

A. Medical Applications

Because of the last extensive innovations applied on the medical fields, WBAN is now able to handle numerical data and multimedia transmissions. Sensors are placed in, on[11] or around a patient's body in order to communicate the vital parameters such as blood pressure, ECG etc. or motion sensors to monitor movement [12]. Assisted living is also an interesting application able to achieve efficiently gathering, storing and transmitting physiological data via wearable sensors. It substitutes the indoor medical supervision so the patient can be free to move outside the hospital and get a distant treatment (home healthcare monitoring and telemedicine [13].

B. Other Applications

Related to sports, wearable devices also offer a monitoring assistance for top athletes and high level activities lovers. Connected military uniforms now ensure many advantages in the battlefields. Communication, health condition, location etc. are the most targeted options to increase the survivability of soldiers. WBAN is also closely connected to smart cities enabling services related to entertainment and life style such as driving navigation, walking and so on[14].

IEEE 802.15 Wireless Personal Area Networks

Designed for low cost devices, this task group of WPAN is based on Bluetooth technology[16]. It supports ad hoc, terrestrial and wireless standard for short-range communication. furthermore, it defines PHY and MAC characteristics for wireless connectivity. This technology includes three classes supporting variable ranges from one to 100 meters.

A. IEEE 802.15.1

Designed for low cost devices, this task group of WPAN is based on Bluetooth technology[16]. It supports ad hoc, terrestrial and wireless standard for short-range communication. furthermore, it defines PHY and MAC characteristics for wireless connectivity. This technology includes three classes supporting variable ranges from one to 100 meters.

B. IEEE 802.15.4

Zigbee is a low tier, ad hoc, terrestrial and wireless standard based on 802.15.4 standard. It is used to create a PAN with small and low-power digital radios. Its low power consumption limits transmission distances to 1–10m line-of-sight, depending on power output and environmental characteristics. This standard proposes three topology types out of four supported by 802.15.4. These common topologies are illustrated in Fig. 1. The Zigbee standard defines the network layer architecture for star, tree and mesh network topologies and affords in the application layer, a framework for application programming.

C. IEEE 802.15.6

BAN task group is mainly serving variety of applications viz. medical (e-health), entertainment (gaming, sports). It makes communications easier and comfortable. This technology is focused on a low-power and low-complexity and short range standard. It has a special design with the aim of optimizing devices which are generaly operated on,in, or around bodies

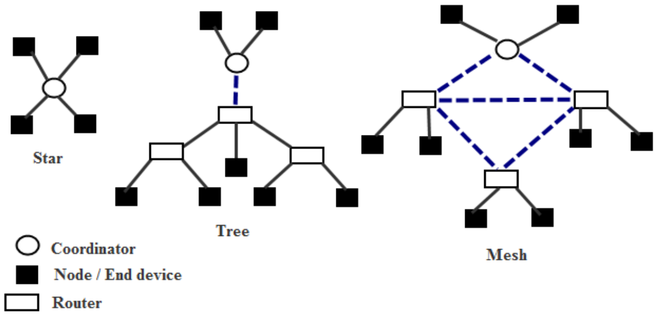

Figure 1: Zigbee standard's topologies

Designing of the WBAN architecture

Thanks to the multi agent systems, wireless sensor networks provided several smart solutions applied to many problematic areas closely related to internet of things. Body Area Networks as an example, has been improved recently especially in the fields of healthcare and ubiquitous systems. This technology consists of many bio sensors capable of gathering data in, on and around a body. The main used ones [9] are listed below:

- Ecg - Electrocardiogram
- Emg - Electromyography
- Eeg – Electroencephalography
- Blood pressure & glucose
- Movement - Activity
- Pressure – feet steps

Fig. 2 shows a standard wban architecture for a healthcare monitoring system.

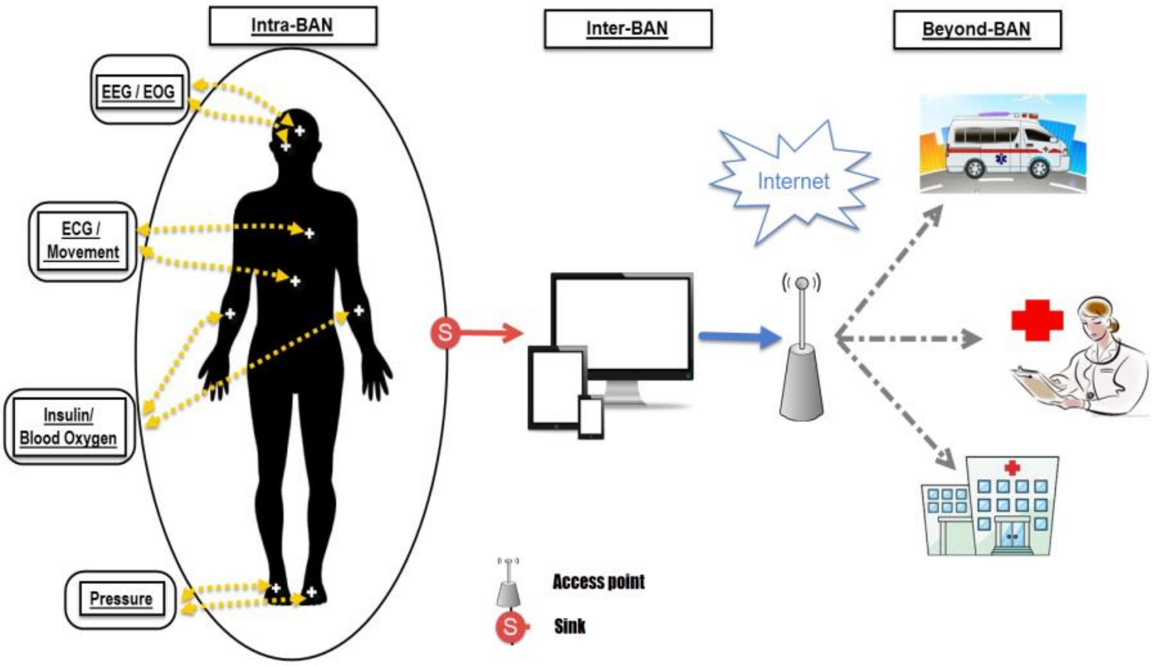

Figure 2: WBAN Healthcare monitoring system

Tableau 1: Apriori/Fp-growth comparison

Framework	Algorithms	
	Apriori	*FP-growth*
Technique	Join & prune	FP-tree Pattern base
Memory	Large memory space if large number of candidates	Less memory (Compact structure)
Number of scans	Multiple scans	Scan the DB twice
Time	Execution time increases due to recursive producing candidates process	Small execution time (smaller than Apriori)

Table 1 shows a comparative study beteween the two used algorithms in this paper, Apriori and FP-growth. Many frameworks are presented such as technique, memory, number of scans and finally complexity or time process calculation.

Apriori Algorithm

```
#Begin

Db=Database;
min_sup=minimum support;
Fre_It=  Frequent  Items;
 T=transaction;
Counter=Number of candidates in Gen_Cand;

For(k=2 ; Fre_It k-1!=0 ; k++)
{
   Gen_Cand=candidates generated from Fre_It k
   Foreach (T in Db)
       do
       {
         Counter++;
         Fre_It k = Gen_Candk
       }
}
Return

#End
```

Algorithm.1 Apriori

Algorithm.1 shows the applied Apriori technique to a medical database of patient's vital sensed data. Itemsets are the vital parameters. If an itemset is frequent, then all of its subsets must also be frequent and the support of the itemeset never exceeds the global support of its subsets. The advantage of Apriori is that it successfully finds frequent elements whatever the database is big or not. However, this algorithm is fast facing a small database. Dealing with bigger databases, it generates a huge number of itemsets which increases the execution time. So it will take more space to save the generated candidates and the computational cost will increase naturally. Figure 4 shows the simulation with a min support of 40% (0.4).

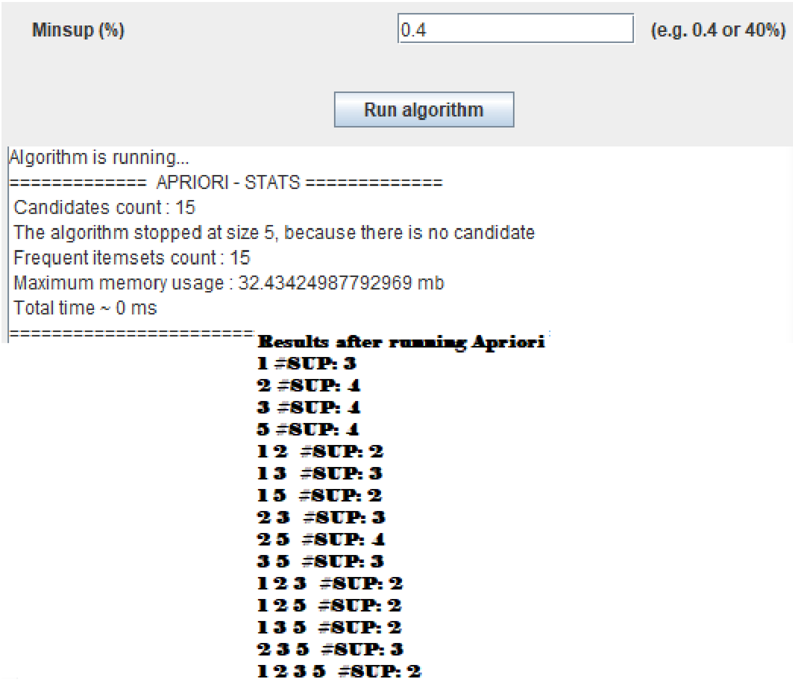

Figure 3: Apriori simulation

<u>Fp-Growth Algorithm (short)</u>

#Begin

TDb= Transactional Database;
min_sup=minimum support;
Fre_It= Frequent Items;
T=transaction;
Counter=Number of candidates in Gen_Cand;

#Step_1 : Data_preprocessing
Call function:minimum_support_threshold( );
Call function:Keep_items( );

#Step_2 : Contruction of the FP-Tree
Call function:Strart_tree_contruction( );
-Scan the transactions
-Sort frequent items
-Insert items in the tree
-Create & add new nodes
-Update node structure

Algorithm.2 FP-Growth

Algorithm.2 shows the applied FP-growth algorithm to a medical database of patient's vital sensed data. Such as algorithm 1, itemsets are the vital parameters. Many steps are demanded to start the execution. First, an initial scan in order to determine the frequencies of the items, then discard all items that not verify the min support threshold. After that sorting in descending order to optimize the algorithm execution. The main next step is to build the FP-tree which is a prefix tree for the transactions. Mostly, there is no need to generate candidate itemsets like Apriori.

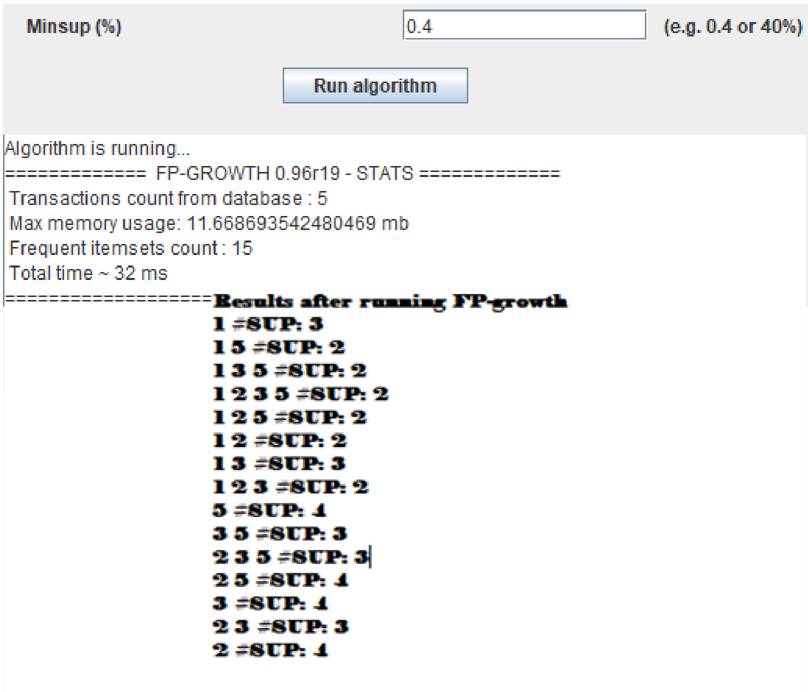

Figure 4: FP-Growth simulation

Conclusion and Future works

In this paper, we introduced an analytic approach of two powerful datamining algorithms. The used database is a transactional one gathered from different sensors of the wban architecture. In the simulation part, we took a 40% min support parameter in order to generate more itemsets. This knowledge will be useful for medical staff to gather analytic information about a patient's state. The aim is to use it to perform a decisional database based on machine learning process. This approach combined with learning techniques and a multi agent system would be useful to trigger new inferences.

References

[1] HAMDI, Omessaad, CHALOUF, Mohamed Aymen, OUATTARA, Dramane, et al. eHealth: Survey on research projects, comparative study of telemonitoring architectures and main issues. Journal of Network and Computer Applications, 2014, vol. 46, p. 100-112.

[2] QADRI, Syed Furqan, AWAN, Salman Afsar, AMJAD, Muhammad, et al. APPLICATIONS, CHALLENGES, SECURITY OF WIRELESS BODY AREA NETWORKS (WBANS) AND FUNCTIONALITY OF IEEE 802.15. 4/ZIGBEE. 2013.

[3] MOVASSAGHI, Samaneh, ABOLHASAN, Mehran, LIPMAN, Justin, et al. Wireless body area networks: A survey. Communications Surveys & Tutorials, IEEE, 2014, vol. 16, no 3, p. 1658-

1686.

[4] SEO, Young-Sun, KIM, Dae-Young, CHO, Jinsung, et al. OCDP: a WBAN MAC protocol for contention-based medical and CE applications. In : Proceedings of the 4th International Conference on Ubiquitous Information Management and Communication. ACM, 2010. p. 12.

[5] Wireless Body Area Networks Standard, IEEE Std. 802.15.6, Feb. 2012

[6] Z. Sun, H. Li, H. Chen and W. Wei, " Optimization Coverage of Wireless Sensor Networks Based on Energy Saving", International Journal of Future Generation Communication and Networking, Vol.7, No.4, pp.35-48, 2014.

[7] S.M. Nuwangi, C. R. Oruthotaarachchi, J.M.P.P. Tilakaratna, H. A. Caldera, "Utilization of Data Mining Techniques in Knowledge Extraction for Diminution of Diabetes", Second Vaagdevi International Conference on Information Technology for Real World Problems (VCON), 9-11 Dec, 2010

[8] A. Lekha, Dr. C V Srikrishna and Dr. VijiVinod, "Utility of Association Rule Mining: a Case Study using Weka Tool", 2013 International Conference on Emerging Trends in VLSI, Embedded System, Nano Electronics and Telecommunication System (ICEVENT),7-9 Jan, 2013

[9] R.chefira, S.rakrak "Internet of Things: a healthcare Ubiquitous-based approach for medical seizure prevention" 2017 International journal of computing academic research Volume 6, number 2, pp 77-82

[10] V. Vaidehi, M. Vardhini, H. Yogeshwaran, G. Inbasagar, R. Bhargavi, and C. Hemalatha, "Agent based health monitoring of elderly people in indoor environments using wireless sen-sor networks," Procedia Computer Science,vol.19,pp.64–71,2013,The4thInternationalConferenceonAmbientSystems,Networks and Technologies (ANT 2013), the 3rd International Conference on Sustainable Energy Information Technology (SEIT-2013).

[11] Patel, S., Park, H., Bonato, P., Chan, L. and Rodgers, M. (2012) A Review of Wearable Sensors and Systems with Application in Rehabilitation. Journal of NeuroEngi-neering and Rehabilitation, 9, 21. https://doi.org/10.1186/1743-0003-9-21

[12] Chen, W., Bouwstra, S., Bambang Oetomo, S. and Feijs, L.M.G. (2011) Sensor Integration for Perinatology Research. International Journal of Sensor Networks, 9, 38-49. https://doi.org/10.1504/IJSNET.2011.037303

[13] Darkins, A., Ryan, P., Kobb, R., Foster, L., Edmonson, E., Wakefield, B. and Lancaster, A.E. (2008) Care Coordination/Home Telehealth: The Systematic Implementation of Health Informatics, Home Telehealth, and Disease Management to Support the Care of Veteran Patients with Chronic Conditions.Telemedicine and e-Health , 14, 1118-1126. https://doi.org/10.1089/tmj.2008.0021

[14] Ragesh, G.K. and Baskaran, K. (2012) An Overview of Applications, Standards and Challenges in Futuristic Wireless Body Area Networks. International Journal of Computer Science Issues, 9, 180-186.

[15] Wireless Body Area Networks Standard, IEEE Std. 802.15.6, Feb. 2012

[16] Institute of Electrical and Electronics Engineers. IEEE Std 802.15.1-2005, Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Wireless Personal Area Networks (WPANs), 14 June 2005- http://standards.ieee.org/getieee802/download/802.15.1-2005.pdf