Developing A Learning Knowledge-Based System For Diagnosis And Treatment Of Malaria

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Abstract

Malaria is a disease that significantly affects the poor who suffer economic, social and educational deprivation. Malaria is accountable for between 1.5 and 2.7 million deaths worldwide each year and at least 30% of all malaria deaths take place in complex emergencies. This is because of shortage of professionals and scarcity of laboratory equipment, especially in developing countries.In the efforts to address such problems, it is important to develop Knowledge-based system (KBS) that can provide support for health professionals and patients to facilitate diagnosis and treatment of malaria patients.However, it does not update the knowledge once it is developed without the involvement of knowledge engineer. The aim of this research was developing learning knowledge based system for diagnosis and treatment of malaria.Knowledge Engineering research design was used to developed prototype system. Purposive sampling technique was used to select domain experts for knowledge acquisition. The knowledge was acquired using both structured and unstructured interviews from domain experts and represented by production rule. Developing the system in local languages, improving the user interface and applying other techniques are the future works of the study.

Keywords: Malaria, Knowledge Based System, Knowledge Engineering, Rule based system

1. INTRODUCTION

Malaria is a complex disease. It is a disease that significantly affects the poor who suffer economic, social and educational deprivation. Two billion people in over 100 countries live in areas where malaria is prevalent. Malaria is accountable for between 1.5 and 2.7 million deaths worldwide each year and at least 30% of all malaria deaths take place in complex emergencies[1].This is because of shortage of professionals and scarcity of laboratory equipment, which is especially the case in developing countries. Therefore, it is difficult to diagnosis and treatment of malaria in such like conditions.

Artificial Intelligence (AI) is a field of science and engineering concerned with the computational understanding of what is commonly called intelligent behaviour, and with the creation of artifacts that exhibit such behaviour [2].From different definitions according to different scholars, it is the part of computer science concerned with designing intelligent computer systems, that is, systems that exhibit the characteristics associated with intelligence in human behaviour such as understanding language, learning, reasoning and solving problems [3].As mentioned in the above definition one of the human intelligence behaviour is problem solving behaviour,which is the focus of this study.

KBS, natural language processing, robotics, speech understanding, speech (voice) recognition, computer vision and scene recognition, intelligent computer-aided instruction, neural computing, intelligent agents, automatic programming, translation of languages, and summarizing news can all be considered as AI technologies.

KBS is one of the major family members of the AI group [4].It is a computer program that represents and reasons with knowledge of some specialist subject with a view to solving problems or giving advice. It is a type of application program that makes decisions or solves problems in a particular field by using knowledge and analytical rules defined by experts in that field [5]. KBSs are meant to solve real problems which normally would require a specialized human expert (such as a doctor in medical field). Building a KBS therefore first involves extracting the relevant knowledge from the human experts.

Learning is the process of KBS by taking new facts or/and rules and remembers that facts or/and rules

next time when the system is used[6]. Developed KBS can modify its knowledge by integrating the learning component into their structure. It can update new signs and symptoms and new treatments at any time when it is necessary.

The major technologies and algorithms to develop KBS are rule based reasoning, case based reasoning, neural networks, intelligent agents, fuzzy logic, and genetic algorithms [7].

2. Statement Of The Problem

At present, malaria surveillance systems detect only around 10% of the estimated global number of cases. Malaria still poses a real threat to travelers, particularly in areas with high transmission rates such as sub-Saharan Africa, Papua New Guinea, and the South Pacific islands. In recent years, only four countries have been certified by the World Health Organization (WHO) Director-General as having eliminated malaria: United Arab Emirates (2007), Morocco (2010), Turkmenistan (2010), and Armenia (2011).Each year, there are an estimated 300-500 million clinical cases. Malaria is estimated to kill more than 1 million people annually, the majority of whom are children.

The concept of AI is very crucial system for diagnosis and treatment of diseases where there is a need of intelligent approach for decision making. However, limitation of some medical intelligent system is that only signs and symptoms entered by the programmer in the knowledge base are available. It does not update the knowledge after it developed without the help of programmers or modifying thecode. But imitation of learning is an essential component of a KBS structure.

Moreover, number of KBS were developed,such asa prototype KBS in antiretroviral therapy [8], designing a KBS for blood transfusion[9], prototype KBS for anxiety mental disorder diagnosis [10],the potential for applying KBS for diagnosis of acute respiratory tract infections [11],human disease diagnosis using a fuzzy expert system [12] and development of online children skin diseases diagnosis system [13] in Ethiopia. However, they are not learning KBSs. Furthermore, tothe knowledge of the researchersthere is no learning KBS for diagnosis and treatment of Malaria. Therefore, the objective of the study is to develop learning KBS for diagnosis and treatment of malaria.

At the end this study will answer the following research questions:

- What are the suitable knowledge for diagnosis and treatment of Malaria?
- It is possible to develop a learning KBS which can efficiently and effectively used for diagnosis and treatment of Malaria?

3. ObjectiveOf The Study

3.1. General Objective

The general objective of the study is to develop a learning KBS for diagnosis and treatment of Malaria

3.2. Specific Objectives

- To acquire and represent domain knowledge from the experts
- To develop a prototype learning KBS for diagnosis and treatment of Malaria

4. Significance

The system developed enables to reduce the problem of the limited numbers of experts in giving preliminary diagnosis and treatment of Malaria. This is because expert's knowledge and experience are stored to help giving accurate and effective result of diagnosis and treating the disease [14].

The focus of all medical systems that are developed is to build better health care facility in order to reduce time, cost and medical error [15].The KBS developed can act as an expert on demand anytime and anywhere (with the availability of power supply and computer), by learning from new facts and rules in the course of providing diagnosis and treatment for Malaria suspects.

The immediate beneficiaries of the system are primary health care workers and health professionals working in the diagnosis and treatment of Malaria. Particularly, the developed prototype has great significance for health care workers and nurses to use the experiences of qualified medical professionals for diagnosis and treatment of Malaria.

5. Methodology

5.1. Research Design

Knowledge engineering is the task of gathering and inputting knowledge for use in knowledge-based computer systems. It plays important role in development of various technologies such as: expert systems, neural network, artificial intelligence, hybrid intelligent systems, data mining, decision support systems, and knowledge based systems[16].Though different styles and methods of knowledge engineering exist, the basic approach is the same: a knowledge engineer interviews and observes a human expert or a group of experts and learns what the experts know, and how they reason with their knowledge. The knowledge engineer then translates the knowledge into a computer-usable language, and designs an inference engine, a reasoning structure, that uses the knowledge appropriately. Therefore, the research design for this study was knowledge engineering approach, which includes knowledge acquisition, knowledge representation and modeling and lastly developing prototype learning KBS.

5.2. Study Area, Population And Sampling Technique

The researchers were selected Jimma University specialized hospital and Adama hospital.

JimmaUniversity specialized hospital, which is found in Oromia regional state, Jimma town in Jimma University main campus whereas Adama hospital is found in Oromia regional state, Adama town. The populations of this study were the technical staffs of Jimma university specialized hospitaland Adama hospital. The total population for interview is 12. Purposive sampling is one of the most common sampling techniques in qualitative research in which participants were decided to preselected criteria relevant to a particular research question [17]. In this study purposive sampling technique was used to select domain experts for knowledge acquisition from the above hospitals. The criteria used in selecting the domain experts for the study considered their professions, educational qualification level, years of experience on malaria or related diseases. Therefore,3 doctors and 3 health officers were selected for interviews from each hospital.

5.3. Source of Data

The researchers used primary and secondary data as source of information. The primary data was collected by using interviews from domain experts and the secondary data was collected from published, public or private documents, books, journals articles, different past researches, reports, manuals published by different organizations like WHO and online materials.

5.4. Data Collection Method

For primary data collection interview was employed to collect domain knowledge (tacit) from the domain experts. In addition document analysis was used to extract explicit knowledge from secondary sources of data.

5.5. Implementation Tool

There are KBS shell with the readymade utilities of self-learning, explanation and inference. Like Java Expert System Shell (JESS), GURU, Vidwan are more specific and can also be useful to develop KBSs.The prototype KBS was implemented by using Swi prolog whichit is open sources programming language and popular.

6. IMPLEMENTATION AND EXPERIMENTATIONS

In the following sections, the implementation includes the real construction of the learning KBS for diagnosis and treatment of malaria. After the necessary knowledge was represented using a rule-based knowledge representation technique, the next step is coding the represented knowledge using Prolog programming language into a suitable format that is understandable by the inference engine.

6.1. Architecture of the Prototype System

Architecture defines how the system is constructed, describes what the critical components were and how they fit together. A KBS tool is a software development environment containing the basic components of KBSs. The core components of developed learning KBS are shown in figure 1.

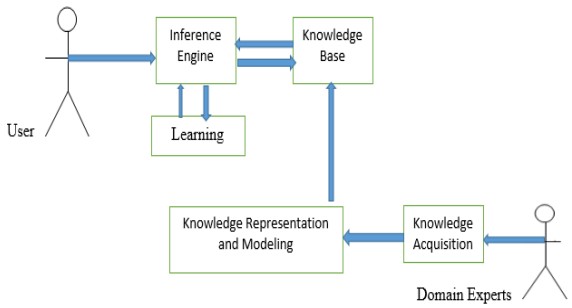

Fig. 1:Architecture of the prototype system

6.2. A Learning Prototype System

An important area of KBS research is the development of practical approaches that enable users to add new facts and/or rules to an intelligent system, which would bring computers closer to meeting the challenge of end-user to add new facts and rules. Therefore,the KBS needsto have many intelligent capabilities in order to support the complex dialogues that researchers conducted with the users, integrate the new facts and rules with existing facts and rules, and make appropriate decisions. The prototype system has a capability of learning new facts of signs and symptoms at run time without editing the code by knowledge engineer. It is easy to add new signs and symptoms such assevere, falciparum, vivax, ovale andmalariae by health professionals. The inserted facts are stored on a separate knowledge base and become updated whenever the end-user ends the program. Since, the system use the updated rules later, the researchersassumed that the users provide correct and professional inputs only when it is required to add new knowledge. Figure 2 show how to add new signs and symptoms in the prototype system.

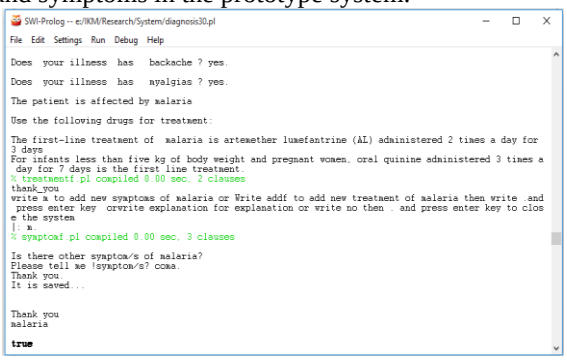

Fig.2: How to add new signs and symptoms

The prototype system can remember the new added signs and symptoms. Figure 3 below shows when the developed system use new facts after it was added by domain experts. For instance **coma** is added as new fact in the prototype system and used as new fact. The following figure shows how the prototype uses the new added signs and symptoms.

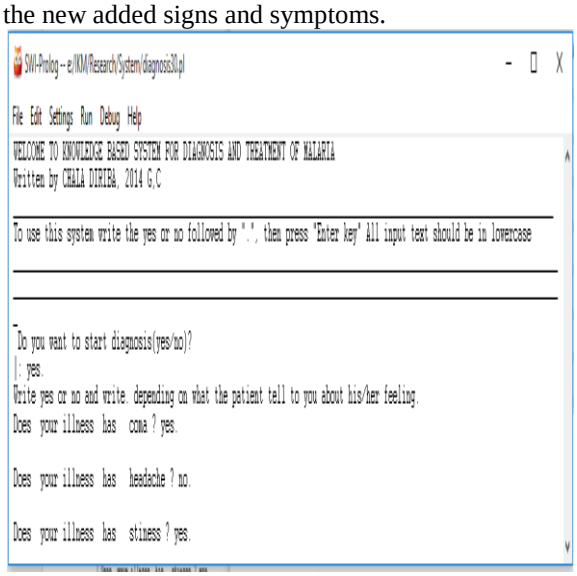

Fig.3: How to use added new signs and symptoms

In addition, the system can learn new treatments if there is any uncovered treatment or the new treatment is discovered.

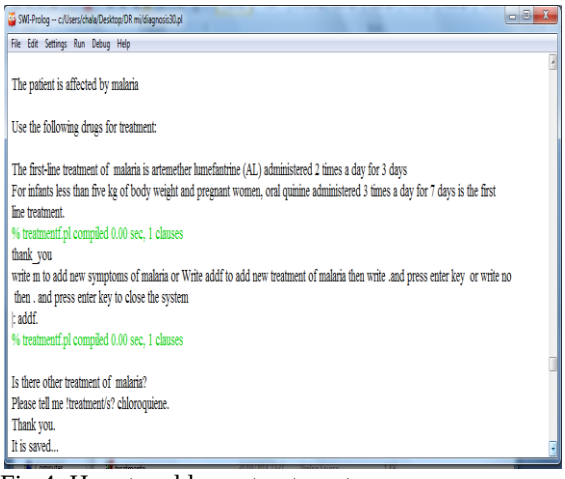

Fig.4: How to add new treatment

7. CONCLUSION AND RECOMMENDATION

7.1. Conclusion

Malaria is a problem in many countries of the world. The problem is greatest in Africa, where over 80 percent of malaria cases and deaths occur. The disease affects all ages and economic groups with a devastating impact on pregnant women and children less than five years of age. Early diagnosis and treatment will save lives and prevent the development of complications of malaria.To minimize the impact of this deadly disease using systems such as the one we developed is paramount. The developed system can be usedfor diagnosis and treatment of malaria where there is shortage of health professionals and/or lack of laboratory equipment and can learn new facts about signs and symptoms and treatments.

7.2. Recommendation

- During KBSdevelopment the challenges faced were acquiring knowledge from the domain experts, therefore additional knowledge for diagnosis and treatment of malaria is needed to improve the knowledge base.
- Because of lack SWI prolog interface developing in commercial tools like Java Expert System Shell (JESS), GURU, Vidwan and KEE is recommended.
- Moreover, developing the system in local language, like in Afan Oromo and Amaric is recommended.
- Lastly, developing a KBS by using other techniques (Case based reasoning, Neural network, Hybrid and Ontology) should be considered as a future research work.

References

1. Columbia University. The Earth Institute Columbia University. Columbia: Columbia University,2015.[Online] Available from:http://www.earth.columbia.edu/articles/view/43 /[Accessed 22 November 2015]
2. John Wiley and Sons. Encyclopedia of Artificial Intelligence, Inc. New York,NY,USA,1992
3. Vasant, H. Artificial Intelligence: An Overview, 2006.
4. Eds. S. &Akerkar, R. Advanced Knowledge Based Systems: *Model, Applications & Research*, 2010.
5. Szakwani.Expert System and Knowledge Based Systems, (2007).[Online] Available from: http://www.omandev.net/2007/07/expert-system-and-knowledge-based-systems/[Accessed date: September 28, 2014].
6. Covington, M, D. Nute, and A. Vellino. PROLOG programming in depth. 2nd ed. Glenview IL: Scott, Foresman and Company. Crawford, 1995.
7. Mesti, u. Artificial Intelligence and Expert Systems: *Knowledge- Based Systems*, (2011).
8. Anteneh W., *Prototype Knowledge Based System in Antiretroviral Therapy*, MSc Thesis, Addis Ababa University School of Information Science, Ethiopia, 2004.
9. Guesh, D. *Designing knowledge based system for blood transfusion*, MSc Thesis, Addis Ababa University School of Information Science, Ethiopia,2013.
10. Seblewongel, E. *Prototype knowledge based system for anxiety mental disorder*, MSc Thesis, Addis

Ababa University School of Information Science, Ethiopia, 2012.
11. Solomon. Develop self-learning knowledge based system for diagnosis and treatment of diabetes, MSc Thesis, Addis Ababa University School of Information Science, Ethiopia, 2013.
12. Mir Anamul Hasan, Khaja Md. Sher-E-Alam, Ahsan Raja Chowdhury. Human Disease Diagnosis Using a Fuzzy Expert System, Journal of Computing, Vol. 2, No. 6, June 2010, NY, USA, ISSN 2151-9617, 2010.
13. Munirah, M., Yusof, R., Aziz,J., Chew, S. Development of Online Children Skin Diseases Diagnosis System, 2013.
14. Djam X. and Kimbi Y. Fuzzy Expert System for the Management of Hypertension. *The Pacific Journal of Science and Technology*. 12(1), 390-402, 2011.
15. Margret S., Clara Madonna L. J., Jeevitha P.,Nandhini R. T. Design of a Diabetic Diagnosis System Using Rough Sets, (2013).
16. Aankita Kaur1, MansafAlam. Role of Knowledge Engineering in the Development of a Hybrid Knowledge Based Medical Information System forAtrial Fibrillation, *American Journal of Industrial and Business Management*, 3, 36-41Am J Trop Med Hyg; 80: 882-888,2013.
17. Mack, N., Kathleen, C., and Macqueen, M., Guest, G. and Namey, E. Qualitative research methods: *A data collector field guide*. 1st ed. USA: Family health international,2005)