Available online at www.sciencedirect.com

ScienceDirect

AASRI Procedia 4 (2013) 196 – 201

AASRI Procedia

www.elsevier.com/locate/procedia

2013 AASRI Conference on Intelligent Systems and Control

Chronological Sequence of Developing A Condition-Ction Rule in the Heassy Unit

Kenedy Greyson[a]*, Mathew Mburuma[a], Nsatusile Nzowa[a], Frank Mbano[a], Georgia Rugumira[a], Jumanne Ally[a], Athman Mfinanga[a], Promota Haule[a], Romwald Lihakanga[a], Eunice Abayo[a]

[a]*Intelligent Systems Research Unit, Department of Electronics and Telecommunications Engineering, Dar es Salaam Institute of Technology, P. O. Box 2958, Dar es Salaam, Tanzania*

Abstract

Most agents in a system are designed to operate based on the condition-action rule. The agent system act according to the information acquired by the sensors located in the domain. The aim of this research report is to explain technique used in implementation of a condition-action rules in an agent component of an expert *hea*lthcare *s*upport *sy*stem (*heassy*) unit. Steps and techniques of knowledge search and implementation in the heassy unit is presented.

Keywords: agent, condition-action rule, healthcare, heassy, formulation, knowledge.

1. Introduction

Expert healthcare system unit is a system designed to support health services provision. In conjunction with computer system, the application software uses acquired data from physiological change sensors to

* Corresponding author. Tel.: +255 686-222-123; fax: +255-222-152-504.
E-mail address: kenedyaliila@yahoo.com.

doi:10.1016/j.aasri.2013.10.030

control the domain environment and relay the information to the medical officer in charge. It can also receive a request from the authorized person to know the condition of the domain (patient).

2. Knowledge tank: condition-action rule

Most knowledge based expert machines are designed in condition-action (C-A) rule. Sets of rules are created for specific task environments. A main task of an expert healthcare system unit is to ensure that the patient physiological changes are monitored closely as it would be if he or she was admitted in the hospital. The condition of the patient determines the action to be taken. Therefore, the system is an (if…then) driven action.

Moreover, many developed programs are condition-action rule based. For instance, almost all games are governed by sets of rules. If you are serving or receiving first at the start of any game, you shall serve or receive in the right service court when your side or your opponent's side scored an even number of points. Now rules can be set from this argument. The violation of the rule has a consequence and action against the person is taken. However, it must be noted that, the exploit of rules is possible only if the system is observable. In the case of badminton, referee and his or her assistants, monitors the game to ensure that, rules are obeyed. Back to our system of expert healthcare system unit, the rules used to govern the system are designed based on the objective. The expert system condition is defined by the input parameter status. The domain must be observable all time so as to state the condition of the system. Figure 1 depicts the scheme of developing condition-action rule of the expert system.

During the process of condition-action rule, the problem is to achieve the optimal decision (Vlassis, 2007). It is not the matter of action but the best action for each domain state. The domain is observed by perceiving its environment through sensors. The availability of measurements determines the state of the domain (*condition*) which in turns activates the respective response (action). Therefore, the observability of the system is assumed all time. Observability is a vital issue and must be addressed properly.

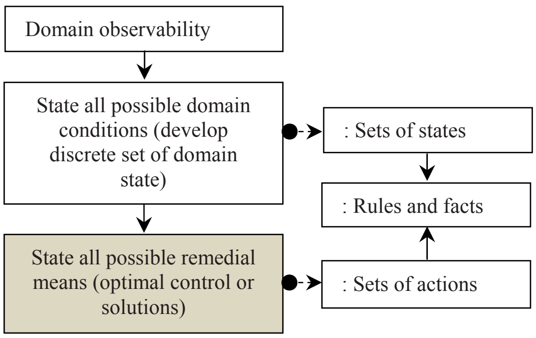

Fig. 1. The scheme of developing condition-action rule of the system

3. Observability

The collected data contained in the domain at a time provides the knowledge of the domain state s_t, at that time. The set of all states of the domain will be denoted by S. In our context, the discrete states, with finite number of state are assumed. Depending on the nature of the problem, the continuous states, with infinite number of states may exist in other types of systems. The domain is fully observable if all sensors at a time completely provide data of the domain. If the observed domain at a time is denoted by θ_t, then for a fully observed domain $\theta_t = s_t$. If only partial data about the domain is presented, the domain is said to be partially observable. In this case the observed state θ_t is not necessarily equal the domain state s_t. It can be said that, the domain state is a probability given the observation.

$$p(s_t \mid \theta_t) = 1 \qquad \textit{for fully observed domain} \tag{1}$$

This implies that the probability of the domain state is confident. In other words, the probability of state given observation is unity.

$$0 \le p(s_t \mid \theta_t) \le 1 \, \textit{for partially observed domain} \tag{2}$$

The probability of attaining the state of a partially observed is more intricate than is for fully observed domain.

4. Conditions

In this section, the first part of antecedent or domain status is discussed. Sets of domain status form conditions of the domain. The action can be for a single condition or for a combination of conditions. If two or more conditions of the domain are needed for an action, the two conditions are said to be dependent conditions, otherwise the condition is a dependent condition. In this section a two-fold state is discussed.

4.1 Independent conditions

Consider a smart home health system, with five different physiological transducers (equipment) that gives bioelectric signals for diagnosis purposes: electrocardiogram (ECG), electromyogram (EMG), Blood Volume Pulse (BVP), thermometer, and phonocardiograph (PCG). These outputs are incorporated in pathology to provide the patients' state. The state can be displayed, stored, transmitted, or alarming the medical person in-charge. Each physiological transducer determines its own test. For example, ECG checks the electrical waves of the activities of the contractions of heart. The abnomal condition observed i ECG does not depend or affect the EMG reponse. This is considered as an *independent condition*. If $d_1^{(+)} = 1$ then the response, discussed later in this chapter, r_1 is taken as the solution. This combination assumes other measurements to be negative, summarized as $\sim d_1, \sim d_2, \sim d_3, \sim d_4, \sim d_5 = 0$. Table 1 shows the independent conditions or states provided by three inputs in a patients' domain.

The dot ($\bullet$) operator represents all conjunctions (and) in prepositional logics. If we include disjunction (or) operator, ($\vee$) and form a combination such as $(\sim d_1 \bullet \sim d_2) \vee d_3$; then, the action for $(\sim d_1 \bullet \sim d_2)$ or action for d_3 may be applicable. Since from the axiom $d_2^{(-)} \rightarrow \sim d_2 = 0$ stated earlier shows that $(\sim d_1 \bullet \sim d_2) = 0$, then $(\sim d_1 \bullet \sim d_2) \vee d_3$ is equivalent to $0 \vee d_3 = d_3$. Let us take another example of expression $\sim d_1 \bullet (\sim d_2 \vee d_3)$. Since $(\sim d_2 \vee d_3) = 0 \vee d_3 = d_3$, then, the expression can be simplified as $\sim d_1 \bullet d_3 = 0 \bullet d_3 = d_3$. In these examples, the following distributive law axiom is applicable in propositional logics.

<u>*Axiom 1*</u>: (Distributive law)

$$(\sim d_1 \bullet \sim d_2) \vee d_3 = \sim d_1 \bullet (\sim d_2 \vee d_3) \tag{3}$$

The human body is a system combining different organs. Malfunction of one organ may affect another organ and even the whole system. In this case, condition 1 may affect condition 2 or vice versa. These states are *dependent conditions*.

4.2 Dependent conditions

In pathology and human anatomy, there is a possibility of a disease to have two or more symptoms at a time. This invites a combination of these symptoms and action is for the combination. A dependent condition is the state of a domain with more than one positive (+) record. In a system with k different physiological transducers, there are k dependent conditions, one (1) normal condition. For a clarification, consider a simple smart home health system with three (3) physiological transducers, there are three (3) dependent conditions, one (1) normal condition, and the rest are dependent conditions. Table 3.2 shows the dependent conditions or states in a patients' domain when three (3) physiological transducers are used.

5. Actions

The second part that responds to the condition or state of the domain (antecedent) is a *consequent*. At time t the state of a domain $s_t \in S$ has a corresponding action $a \in A$. There are various methods used in choosing the optimum action. A condition, be an independent or dependent has an action. As it was mentioned before, some conclusions depend on facts and principles behind the given condition. These facts come after deduction of arguments. The deductive arguments act as a solution indicator. For example, if the physiological transducer state is high (40^{o} C for instance), it can be concluded that the patient has fever. Note that, high temperature can be a symptom of other diseases. This is the reason for consulting medical experts in a higher level of health services.

Table 1. Independent conditions or states for three (3) inputs

Inputs			Unified Consequent representation	Simplified representation
d_1	d_2	d_3		
0	0	1	$\sim d_1 \bullet \sim d_2 \bullet d_3$	d_3
0	1	0	$\sim d_1 \bullet d_2 \bullet \sim d_3$	d_2
1	0	0	$d_1 \bullet \sim d_2 \bullet \sim d_3$	d_1

Table 2. Dependent conditions or states for three (3) inputs

State	Inputs			Unified Consequent representation	Simplified representation, $d_k^{(-)} = 0$
	d_1	d_2	d_3		
1	0	1	1	$\sim d_1 \bullet d_2 \bullet d_3$	$d_2 \bullet d_3$
2	1	0	1	$d_1 \bullet \sim d_2 \bullet d_3$	$d_1 \bullet d_3$
3	1	1	0	$d_1 \bullet d_2 \bullet \sim d_3$	$d_1 \bullet d_2$
4	1	1	1	$d_1 \bullet d_2 \bullet d_3$	$d_1 \bullet d_2 \bullet d_3$

Although the smart home health systems communicate with high level health services to consult medical experts, a knowledge database could assist in a well framed system. The system with database, regardless of its location, (within a network reach) can respond to the smart home health system. The communication language between the systems must be clearly stated.

The logical function of implication (*if ... the*) is denoted by the symbol "$\supset$". For example, if domain state s_t then action a_n is issued. This is expressed as $s_t \supset a_n$. Two or more actions can respond to a domain state.

This is expressed as. $s_t \supset (a_1 \vee a_2 \vee a_n)$ This can express the situation of high temperature as a symptom of more than one disease. The expression $s_t \supset (a_1 \bullet a_2 \bullet ..., \bullet a_n)$ means that, if the domain state is s_t then all actions a_1, a_2 and a_n are required. $s_t \supset (a_1 \bullet a_2 \bullet ..., \bullet a_n)$.

In smart home health system, the deduced conclusion drawn represents the translation of the domain status of the patient and alerts the in-charge of the patient (nurse or family member). The following are examples gives the combined scenario of conclusion based on the domain status observed:

- If the body temperature is above 38°C (depending on the location of the measurement) conclusion is generally considered to be febrile.
- Fever can also be a symptom of malaria, hyperlipidaemia (elevated concentrations of the lipids in the plasma), and many other. Decision of the problem is yet probabilistic.
- From the list of possible conclusions, the conclusion with higher probability will be considered the better choice.
- Appropriate action corresponding to the conclusion is taken, such as, initial care to the patient, calling the doctor; give the medicine, and others.

Therefore, in smart home health system, physiological sensors gather data of the patients and obtain the state of the patient. To conclude if the patient has fever will depend on the state of the domain to have high temperature. Similarly, the low pressure is concluded if the pressure reading is low. The conclusion is a probabilistic. The events of high temperature, low-pressure, high, and others may occur together independently or dependently. The probability of patient to have fever given the temperature is high is reasonably high than when the temperature is low. The knowledge in nature of relationship of domain state (sensory observations) and the action of the smart home health system is required.

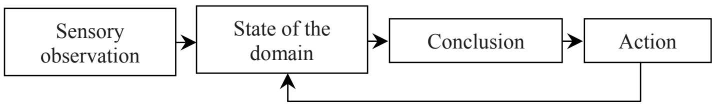

Fig. 2. Input response relationship

6. Conclusion

The concept of formation of rules and facts required in development of an expert system has been articulated. The art of the knowledge searching, manipulation, and action can be discussed in details in the following chapters. In conclusion, the smart home health system is expected to be rational. Two actions that conflict would be make it dull system.

References

[1] MNH. Muhimbili National Hospital. http://mnh.co.tz. Accessed: October 12, 2012.
[2] Negnevitsky M. Artificial Intelligence: A Guide to Intelligent Systems. Second Edition, Addison Wesley; 2005.
[3] Hsiao WC, Li KT. What is a Health System? Why Should We Care? Harvard School of Public Health; 2003.
[4] System. Dictionary.com. Collins English Dictionary - Complete and Unabridged. 10th Edition. Harper Collins Publishers. http://dictionary.reference.com/browse/system. Accessed: January 30, 2013.

[5] NHP, URT. National Health Policy. United Republic of Tanzania. Ministry of Health; 2003.
[6] Weiss L, Silver JK, Weiss J. Easy EMG. Butterworth-Heinemann; 2004.
[7] Khan MG. Rapid ECG Interpretation. Third Edition, Humana Press; 2008.
[8] Combatalade DC. Basics of Heart Rate Variability Applied to Psychophysiology, Thought Technology Ltd. http://www.emfandhealth.com/HRVThoughtTechnology.pdf. Accessed: January 31, 2013.
[9] Khandpur RS. Biomedical Instrumentation Technology and Applications, McGraw-Hill; 2005.
[10] Nikos Vlassis (2007). A Concise Introduction to Multiagent Systems and Distributed Artificial Intelligence. Morgan & Claypool Publishers series; 2007.
[12] Bellifemine F, Caire G, Greenwood D. Developing Multi-Agent Systems with JADE. John Wiley & Sons Ltd.; 2007.
[13] JADE. JADE Agent Development Framework. http://jade.tilab.com. Accessed: December 21, 2012.
[14] Hindriks KV. Programming Rational Agents in GOAL. EEMCS, Delft University of Technology, Mekelweg 4, Delft; 2011.
[15] 2APL(a). 2APL A Practical Agent Programming Language: User Guide. http://tenet.dl.sourceforge.net/project/apapl/UserGuide/manual.pdf. Accessed: May 11, 2011.
[16] 2APL(b). Download Latest 2apl (Beta). http://apapl.sourceforge.net/. Accessed: February 13, 2012.
[17] Negnevitsky M. Artificial Intelligence: A Guide to Intelligent Systems. Second Edition, Pearson Education Limited; 2005.