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AASRI Procedia 4 (2013) 196 – 201

2013 AASRI Conference on Intelligent Systems and Control

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

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**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.

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Selection and/or peer review under responsibility of American Applied Science Research Institute

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

# 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

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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).

# 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.



State all possible domain conditions (develop discrete set of domain state)

Domain observability

State all possible remedial means (optimal control or solutions)

: Sets of actions

: Rules and facts

: Sets of states

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

# Observability

The collected data contained in the domain at a time provides the knowledge of the domain state *st* , 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 *t* , then for a fully

observed domain *t * *st* . If only partial data about the domain is presented, the domain is said to be partially

observable. In this case the observed state *t* is not necessarily equal the domain state *st* . It can be said that, the domain state is a probability given the observation.

*p*(*st* | *t* )  1

*for fully observed domain (1)*

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

0  *p*(*st* | *t* )  1 *for partially observed domain (2)*

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

# 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.

* 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 (  )  1 then the response, discussed

*d*

1

later in this chapter, *r*1

is taken as the solution. This combination assumes other measurements to be negative,

summarized as

 *d*1 ,

*d*2 ,

*d*3 ,

*d*4 , *d*5

 0 . Table 1 shows the independent conditions or states provided by

three inputs in a patients’ domain.

The dot (  ) operator represents all conjunctions (and) in prepositional logics. If we include disjunction (or)

operator, (  ) and form a combination such as ( *d*1

 *d*2 ) *d*3 ; then, the action for ( *d*1

 *d*2 ) or action for

*d*3 may be applicable. Since from the axiom *d* ( )

2

 *d*2  0 stated earlier shows that ( *d*1

 *d*2 )  0 , then

( *d*1

 *d*2 )

*d*3 is equivalent to 0  *d*3

 *d*3 . Let us take another example of expression

 *d*1  ( *d*2

*d*3 ).

Since ( *d*2

*d*3 )

 0  *d*3

 *d*3 , then, the expression can be simplified as

*d*1  *d*3

 0  *d*3

 *d*3 . In these

examples, the following distributive law axiom is applicable in propositional logics.

*Axiom 1*: (Distributive law)

*(d*1  *d*2 *) * *d*3 *= d*1  *(d* 2  *d*3 *) (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*.

* 1. *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.

# 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 *st * *S* has a corresponding action *a * *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 (40o 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

Simplified

|  |  |  |  |
| --- | --- | --- | --- |
| *d*1 | *d*2 | *d* 3 | representation representation |
| 0 | 0 | 1 | *d*1 *d*2 *d*3 *d*3 |
| 0 | 1 | 0 | *d*1 *d*2 *d*3 *d*2 |
| 1 | 0 | 0 | *d*1 *d*2 *d*3 *d*1 |

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

State Inputs Unified Consequent

Simplified representation, *d* ( )  0

*d*1 *d* 2 *d* 3 representation *k*

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | 0 | 1 | 1 *d*1 *d* 2 *d*3 *d* 2 *d*3 |
| 2 | 1 | 0 | 1 *d*1 *d* 2 *d*3 *d*1 *d*3 |
| 3 | 1 | 1 | 0 *d*1 *d* 2 *d* 3 *d*1 *d* 2 |
| 4 | 1 | 1 | 1 *d*1 *d* 2 *d* 3 *d*1 *d* 2 *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 “  ”. For example, if domain state

*st* then action *an* is issued. This is expressed as *st * *an* . Two or more actions can respond to a domain state.

This is expressed as. *st*

 (*a*1  *a*2

 *an* ) This can express the situation of high temperature as a symptom of

more than one disease. The expression *st*

 (*a*1  *a*2

 ...,*an* ) means that, if the domain state is *st*

then all

actions *a*1, *a*2 and *an* are required. *st*

 (*a*1  *a*2

 ...,*an* ) .

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.



State of the domain

Sensory observation

Action

Conclusion

Fig. 2. Input response relationship

# 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.

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