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Rule Based System for Diagnosing Wireless Connection Problems Using SL5 Object

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ABSTRACT

There is an increase in the use of in-door wireless networking solutions via Wi-Fi and this increase infiltrated and utilized Wi-Fi enable devices, as well as smart mobiles, games consoles, security systems, tablet PCs and smart TVs. Thus the demand on Wi-Fi connections increased rapidly. Rule Based System is an essential method in helping using the human expertise in many challenging fields. In this paper, a Rule Based System was designed and developed for diagnosing the wireless connection problems and attain a precise decision about the cause of the problem. SL5 Object expert system language was used in developing the rule based system. An Evaluation of the rule based system was carried out to test its accuracy and the results were promising.

Keywords: *Data Based System, Wireless connection, SL5 Object, Diagnosing, Wi-Fi.*

1. INTRODUCTION

Artificial Intelligence is the field that seeks to "build systems that exhibit intelligent behavior and perform complex tasks with a level of competence that is equivalent or superior to the level currently exhibited by human experts" [1,2,3,6]. Rule Based Systems are one of the subfields of artificial intelligence. Since its beginning, Rule Based Systems have been utilized to help mankind with problems within a limited scope. An Rule Based System is an interactive computer based decision tool that uses both facts, rules and heuristics to solve complex decision making problems, based on knowledge solicited from a human expert, i.e., a Rule Based System is a computer program that imitate the cognitive process of a human expert to resolve complex decision problems in a particular domain [7,8,9,10].

2. RESEARCH OBJECTIVES

The primary goals of rule based system is:

- To make expertise available to technicians and decision makers who need quick response to their questions. There is no sufficient expertise to go around, surely it is not always on hand at the right time and the right place.
- To give people a chance to know the problems in their systems by themselves, without the need of a human expert to identify the problem. That mean it is free compared with expert checkup cost.
- To assist in publishing wireless communication problems solutions and make dealing with the problem very easy.

3. COMPONENTS OF EXPERT SYSTEM

3.1 Knowledge base

Is a set of knowledge, experience, facts and the rules associated with specific field, for example, (medicine, engineering, physics, etc.), This rule set represents the experience gained from the work and research in this field , this knowledge base is in form of (rule based, form based, object based, case based) [21].

3.2 Inference engine

The inference engine apply rational rules to the knowledge base and infer new knowledge. This process would repeat as each new fact in the knowledge base might trigger further rules in the inference engine. Inference engines work mainly in one of two modes either special rule or facts: forward chaining or backward chaining. Forward chaining begins with the given facts and adds new facts. Backward chaining begins with goals, and works backward to find out what facts should be added so that the goals can be attained[22].

3.3 User interface

This is the system that allows a non-expert user to query (question) the expert system, and to receive advice. The user-interface is designed to be a simple to use as possible. Users can communicate with the expert system via[23] :

- Lists choice
- Natural Languages
- Direct interaction with the user

3.4 Knowledge Engineer

Works on improvement and development of different programs that represent expert system components, where he/she can insert the facts and the rules into different expert system[22].

3.5 Domain expert

A person who has the experience in a specific field which he/she is working in, for example if the expert system was specialist at psychology so, the domain expert is psychologist[21].

4. PROBLEM DESCRIPTION

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With the increasing use of in-door wireless networking solutions via Wi-Fi and the increasing infiltration and utilization of Wi-Fi enable devices, as well as smart mobiles, games consoles, security systems, tablet PCs and smart TVs, the demand on Wifi connection increased rapidly.

In 2014, Cisco estimated that 32% of mobile data traffic indoors was carried using Wi-Fi. This is forecasted to go up to 48% by 2017. A recent report specially made by the European Commission recognized that over 71% of all wireless data traffic that was transported to tablets and smart mobiles in the EU was transported using Wi-Fi [24].

Due to the increase of the number of devices that are connected to the wireless network, maintaining the wireless connection becomes a severe matter which require experts to solve the day by day connection problems. In this paper, a Rule Based System that uses the expertise of communications and networking experts in maintaining the wireless connection has been designed and developed.

5. LITERATURE REVIEW

Ruled Based systems had been developed for a variety of domains: diagnosing human diseases of the neck, skin, male fertility, foot, low back pain, genital of infant, genital of men, nausea and vomiting, mouth, shoulder, eye, ear, breast cancer, urination, feeding in infants and children. Diagnosing plant diseases. Diagnosing of electrical and/or mechanical equipment, identification of software/hardware problems and integrated circuit failures, as well as fault-detection in nuclear power systems. Guiding freshmen students for selecting a major. Furthermore, selecting exploratory factor analysis procedures [1-5,7-13,14-23].

It is required for a rule based system to recognize the possible causes that could clarify the symptoms and suggest appropriate solutions. To be able to perform the tasks, a rule based system should gather sufficient domain knowledge regularly and dynamically to emulates the reasoning of a human and decision makings anchored in the most updated knowledge [11]. Rule Based systems are naturally very domain specific. The knowledge engineer of such rule based have to bound his or her scope of the system to just what is required to conquer the target problem. Expert System programming languages are frequently wanted to achieve the specific objectives of the system [14-15].

Rule Based systems tenders the reimbursement of increasing the frequency, consistency and probability of making good decisions, serving dispense human expertise, smoothing the progress of real- time, low-cost expert-level decisions by the non-expert. Rule Based systems consists of major system components and interface with individuals in various roles. The major components are (as shown in Fig. 1) [6,18-20].

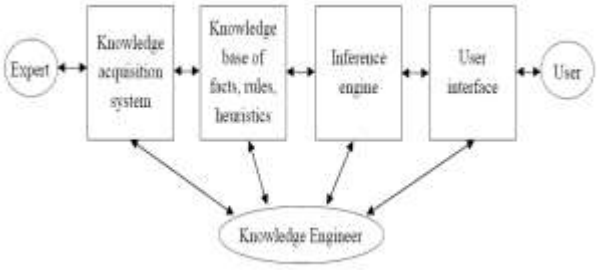

Fig. 1 Rule Based System components and human interfaces

6. METHODOLOGY

The Rule Based System mainly consists of three parts: The knowledge base, the inference engine, and the user interface. In order to interpolate the expertise into the system, SL5 Object expert system language is used as the knowledge base. SL5 Object is considered to be a declarative programming language, i.e. when implementing the solution to a problem, instead of specifying how to achieve a certain goal in a certain situation, we specify what the situation (objects, rules and facts) and let the SL5 Object inference engine derive the solution for us[14].

SL5 Object has a user friendly interface that explain the available options to the user and show the results after reaching the conclusion. Choosing SL5 Object was due to its effectiveness in implementing the user interface, and its platform independency [14].

We used the flowchart in figure 2 to represent the objects, rules and fact of the knowledge base. The knowledge based was stored in SL5 Object Expert System language.

7. EVOLUTION OF THE RULE BASED SYSTEM

This section describes the results of evaluating the Rule Based System for diagnosing the wires communication problems.

A evaluation was performed in the labs of the Faculty of Engineering and Information Technology of Al-Azhar University in Gaza. More than 30 test cases where used to feed data to the rule based system and the diagnosis of each test case was recorded and then compared with the actual diagnosis.

At the end of testing rule based system for diagnosing the wires communication problems, 27 cases out of 31 were successfully diagnosed and 4 cases were partially diagnosed. Thus the evaluation shows a success rate of %87.

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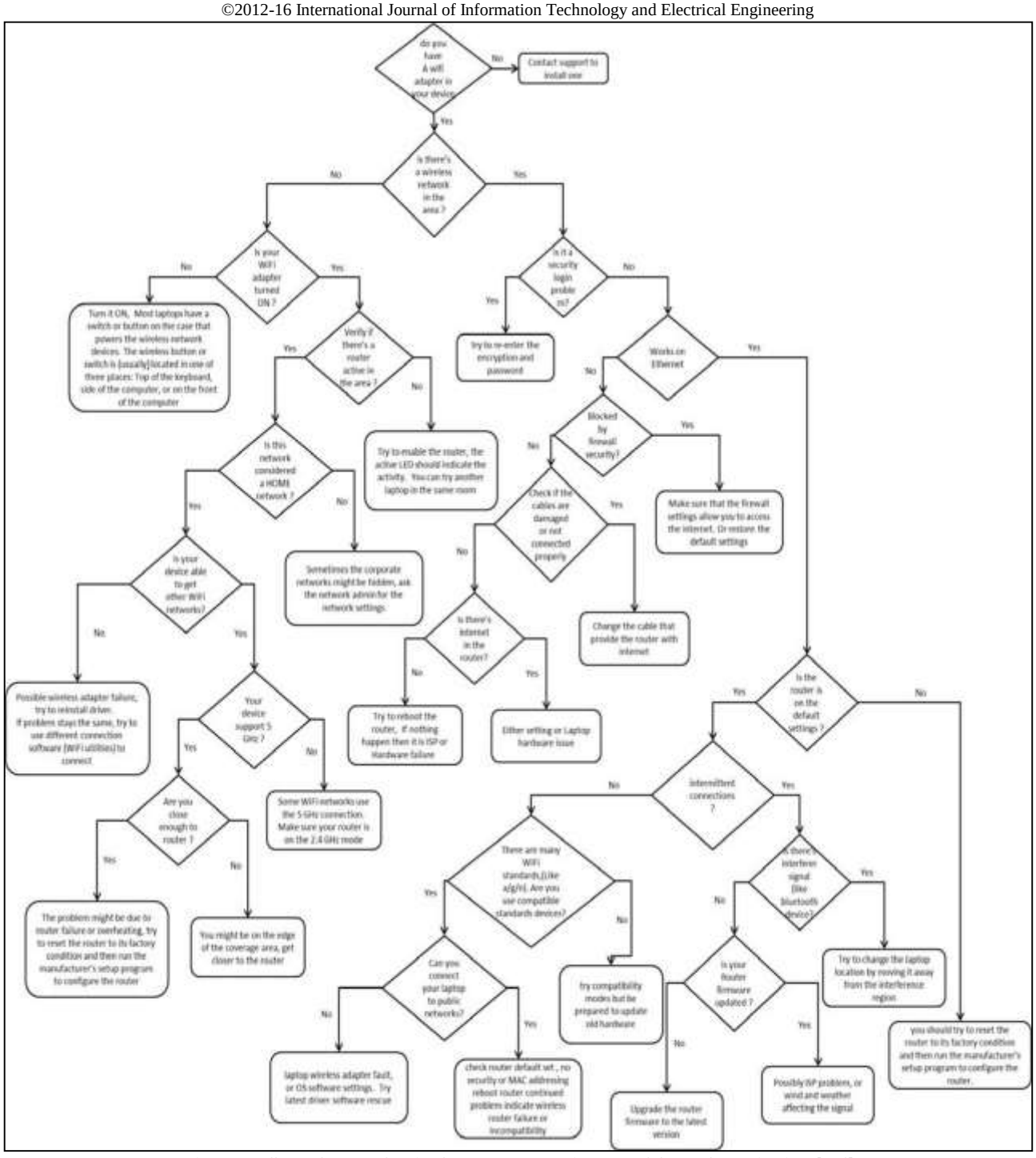

Fig. 2 A flowchart of Wireless Connection problem description[25]

Figure 3 shows the starting session of the rule based system for diagnosing wireless connection problems. Figure 4 and figure 5 shows part of the dialogue between the end user and the rule based system. Figure 6 shows the conclusion of the rule based system, where the diagnosis of the problem is stated and the recommendation outlined for the end user.

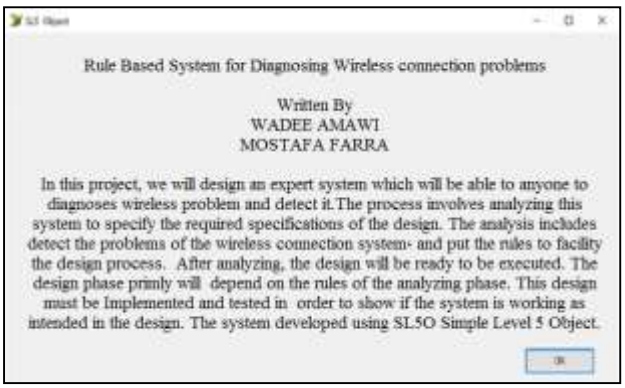

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Fig. 3 User Interface display of the Rule Based System

Fig. 4 Rule Based dialogue question 1

Fig. 5 Rule Based dialogue question 2

Fig. 6 Result of the Rule Based system

8. CONCLUSIONS

There is an increase in the use of in-door wireless networking solutions via Wi-Fi and this increase infiltrated and utilized Wi-Fi enable devices. Maintaining these devices and diagnosing their connection problems requires lots of hard work; therefore, in this paper, a rule based System that used for diagnosing wireless connection problems was designed and developed to help users and technicians in maintaining these devices. An evaluation of the rule based system was performed in the faculty of Engineering and Information. The results of the valuation shows a success rate of 87%.

9. SOURCE CODE OF RULE BASED SYSTEM USING SL5 OBJECT

```
ATTRIBUTE start SIMPLE
ATTRIBUTE Do you have A Wi-Fi adapter in your
device?  COMPOUND Yes, No
 ATTRIBUTE Is there's a wireless network in the area?
COMPOUND Yes, No
ATTRIBUTE Is your Wi-Fi adapter turned on?
COMPOUND Yes, No
ATTRIBUTE Verify if there's a router active in the area?
COMPOUND Yes, No
ATTRIBUTE Is this network considered a HOME
network? COMPOUND Yes, No
ATTRIBUTE Is your device able to get other Wi-Fi
networks? COMPOUND Yes, No
ATTRIBUTE Your device support 5 GHz? COMPOUND
Yes, No
ATTRIBUTE Are you close enough to router?
COMPOUND Yes, No
ATTRIBUTE Is it a security login problem? COMPOUND
Yes, No
ATTRIBUTE Works on Ethernet? COMPOUND Yes, No
ATTRIBUTE Blocked by firewall security? COMPOUND
Yes, No
ATTRIBUTE Check it the cable are damaged or not
connected properly? COMPOUND Yes, No
ATTRIBUTE Is there's internet in the router?
COMPOUND Yes, No
ATTRIBUTE Is the router is on the default settings?
COMPOUND Yes, No
ATTRIBUTE Intermittent connections? COMPOUND
Yes, No
ATTRIBUTE Are you use compatible standards device?
COMPOUND Yes, No
ATTRIBUTE Can you connect your laptop to public
networks? COMPOUND Yes, No
ATTRIBUTE Is there's interferer signal like Bluetooth
device? COMPOUND Yes, No
ATTRIBUTE Is your router firmware updated?
COMPOUND Yes, No

INSTANCE the domain ISA domain
  WITH start: = TRUE

INSTANCE the application ISA application
 WITH title display: = introduction
 WITH conclusion display: = Conc
 WITH numeric precision: = 8
 WITH simple query text" = :
?*
is
" *
  WITH numeric query text: = "What is the value of:
*
of
"*
  WITH string query text" = :
*
of
```

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```
"*
  WITH time query text" = :
*
of
"*
  WITH interval query text" = :
*
of
"*
  WITH compound query text" = :
*
of
"*
  WITH multicompound query text" = :
*
of
"*

INSTANCE introduction ISA display
  WITH wait: = TRUE
  WITH delay changes: = FALSE
  WITH items [1]: = textbox 1

INSTANCE textbox 1 ISA textbox
  WITH location: = 10,10,755,419
  WITH pen color: = 700,700,700
  WITH fill color: = 1,1,1
  WITH justify IS left
  WITH font: = "Arial"
  WITH font style IS bold
  WITH font size: = 14
  WITH text "= :
   Rule Based System for Diagnosing Wireless connection
                    problems

                  Written By
                WADEE AMAWI
              MOSTAFA FARRA

 In this project, we will design an expert system which will
be able to anyone to  diagnoses wireless problem and detect
it.The process involves analyzing this system to specify the
required specifications of the design. The analysis includes
detect the  problems of the wireless connection system, and
put the rules to facility the design process.  After analyzing,
   the design will be ready to be executed. The design phase
     primly will  depend on the rules of the analyzing phase.
    This design must be implemented and tested in  order to
    show if the system is working as intended in the design.
The system developed using SL5O Simple Level 5 Object"

INSTANCE Conc ISA display
  WITH wait: = TRUE
  WITH delay changes: = FALSE
  WITH items [1]: = title textbox
  WITH items [2]: = diagnosis textbox
  WITH items [3]: = advise textbox

INSTANCE title textbox ISA textbox
  WITH location: = 20,10,800,70
  WITH pen color: = 0,0,0
  WITH fill color: = 200,200,100
  WITH justify IS center
  WITH font: = "Arial"
  WITH font style IS bold
  WITH font size: = 14
  WITH text: = " Diagnosing Wireless connection
problems"

INSTANCE diagnosis textbox ISA textbox
  WITH location: = 20,110,800,130
  WITH pen color: = 0,0,0
  WITH fill color: = 170,170,170
  WITH justify IS left
  WITH font: = "Arial"
  WITH font size: = 14
   WITH text" "= :

INSTANCE advise textbox ISA textbox
  WITH location: = 20,280,800,130
  WITH pen color: = 0,0,0
  WITH fill color: = 170,170,170
  WITH justify IS left
  WITH font: = "Arial"
  WITH font size: = 14
  WITH text" "= :

RULE r0
IF start
THEN ASK Do you have a Wi-Fi adapter in your device

RULE r1
IF Do you have A Wi-Fi adapter in your device IS No
THEN text OF diagnosis textbox: = "You don't have A Wi-
Fi adapter"
AND text OF advice textbox: = "Please contact support to
install one"

RULE r2
IF Do you have A Wi-Fi adapter in your device IS Yes
THEN ASK Is there's a wireless network in the area?

RULE r3
IF Is there's a wireless network in the area? IS No
THEN ASK Is your Wi-Fi adapter turned on   ?

RULE r4
IF Is your Wi-Fi adapter turned on IS No
THEN text OF diagnosis textbox: = "Your A Wi-Fi adapter
turned off"
AND text OF advice textbox: = "Turn it ON Most laptops
have a switch or button on the case that powers the wireless
 network devices the wireless button or switch
is(usually)located in one of three places :
 <==top of the keyboard
 <==side of the computer or on the front of the computer"

RULE r5
IF Is your Wi-Fi adapter turned on IS Yes
THEN ASK Verify if there's a router active in the area?
```

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RULE r6
IF Verify if there's a router active in the area? IS No
THEN text OF diagnosis textbox: = "The router is not active in the area"
AND text OF advice textbox: = " Try to enable the router
The active LED should indicate the activity.
You can try another laptop in the same room"

RULE r7
IF Verify if there's a router active in the area? IS Yes
THEN ASK Is this network considered a HOME network?

RULE r8
IF Is this network considered a HOME network? IS No
THEN text OF diagnosis textbox: = "The network is not a HOME network"
AND text OF advice textbox: = "Sometimes the corporate networks might be hidden
Ask the network admin for the network settings".

RULE r9
IF Is this network considered a HOME network? IS Yes
THEN ASK Is your device able to get other Wi-Fi networks?

RULE r10
IF Is your device able to get other Wi-Fi networks? IS No
THEN text OF advice textbox: = "Possible wireless adapter failure, try to reinstall driver.
If problem stays the same, try to use different connection software to connect"

RULE r11
IF Is your device able to get other Wi-Fi networks? IS Yes
THEN ASK Your device support 5 GHz?

RULE r12
IF Your device support 5 GHz? IS No
THEN text OF diagnosis textbox: = "Your device is not support 5 GHz"
AND text OF advice textbox: = "Some Wi-Fi networks use the 5 GHz connection.
Make sure your router is on the 2.4 GHz mode"

RULE r13
IF Your device support 5 GHz? IS Yes
THEN ASK Are you close enough to router?

RULE r14
IF Are you close enough to router? IS No
THEN text OF diagnosis textbox: = "You are far away from the router"
AND text OF advice textbox: = "You might be on the edge of the coverage area,
get closer to the router"

RULE r15
IF Are you close enough to router? IS Yes
THEN text OF advice textbox: = "The problem might be due to router failure or overheating
Try to reset the router to its factory condition Then run the manufacture's
setup program to configure the router "

RULE r16
IF Is there's a wireless network in the area? IS Yes
THEN ASK Is it a security login problem?

RULE r17
IF Is it a security login problem? IS Yes
THEN text OF diagnosis textbox: = "You have a problem in a security login"
AND text OF advice textbox: = "Try to re-enter the encryption and password"

RULE r18
IF Is it a security login problem? IS No
THEN ASK Works on Ethernet?

RULE r19
IF Works on Ethernet? IS No
THEN ASK Blocked by firewall security?

RULE r20
IF Blocked by firewall security? IS Yes
THEN text OF diagnosis textbox: = "You are blocked by firewall security"
AND text OF advice textbox: = "Make sure that the firewall settings allow you to access the internet
Or restore the default settings"

RULE r21
IF Blocked by firewall security? IS No
THEN ASK Check it the cable are damaged or not connected properly?

RULE r22
IF Check it the cable are damaged or not connected properly? IS Yes
THEN text OF diagnosis textbox: = "your cable was damaged"
AND text OF advice textbox: = "Change the cable that provide the router with internet"

RULE r23
IF Check it the cable are damaged or not connected properly? IS No
THEN ASK Is there's internet in the router?

RULE r24
IF Is there's internet in the router? IS Yes
THEN text OF advice textbox: = "Laptop hardware issue"

RULE r25
IF Is there's internet in the router? IS No
THEN text OF diagnosis textbox: = "No internet in the router"
AND text OF advice textbox: = "Try to reboot the router,

if nothing happens then it is ISP or Hardware failure"

RULE r26
IF Works on Ethernet? IS Yes
THEN ASK Is the router is on the default settings?

RULE r27
IF Is the router is on the default settings? IS No
THEN text OF diagnosis textbox: = "the router is not on the default settings"
AND text OF advice textbox: = "You should try to reset the router to its factory condition
and then run the manufacturer's setup program to configure the router"

RULE r28
IF Is the router is on the default settings? IS Yes
THEN ASK Intermittent connections?

RULE r29
IF Intermittent connections? IS No
THEN ASK Are you use compatible standards device?

RULE r30
IF Are you use compatible standards device? IS Yes
THEN ASK Can you connect your laptop to public networks?

RULE r31
IF Can you connect your laptop to public networks? IS Yes
THEN text OF advice textbox: = "Check router default set, no security or MAC addressing reboot router continued problem indicate wireless router failure or incompatibility"

RULE r32
IF Can you connect your laptop to public networks? IS No
THEN text OF advice textbox: = "Laptop wireless adapter fault, or OS software settings. Try latest driver software rescue"

RULE r33
IF Are you use compatible standards device? IS No
THEN text OF diagnosis textbox: = "you are not use compatible device Like (a/g/n)"
AND text OF advice textbox: = "Try compatibility modes but be prepared to update old hardware"

RULE r34
IF Intermittent connections? IS Yes
THEN ASK Is there's interferer signal like Bluetooth device?

RULE r35
IF Is there's interferer signal like Bluetooth device? IS Yes
THEN text OF diagnosis textbox: = "interferer signal in the range"
AND text OF advice textbox: = "Try to change the laptop location by moving it away from the interference region"

RULE r36
IF Is there's interferer signal like Bluetooth device? IS No
THEN ASK Is your router firmware updated?

RULE r37
IF Is your router firmware updated? IS Yes
THEN text OF advice textbox: = " Possibly
<==ISP problem
<==or wind and weather affecting the signal"
RULE r38
IF Is your router firmware updated? IS No
THEN text OF diagnosis textbox: = "your router firmware is not update"
AND text OF advice textbox: = "Upgrade the router firmware to the latest version"

END

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