# A Novel Expert System for Building House Cost Estimation: Design, Implementation, and Evaluation

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***Abstract*—This paper introduces an expert system which demonstrates a new method for accurate estimation of building house cost. This system is simple and decreases the time, the effort, and the money of its beneficiaries. In addition, design and implementation of the proposed expert system are introduced. CLIPS 6.0 and C# are used in implementation phase. Also, this expert system is programmed to be in a standalone package with a platform independency. Furthermore, the developed expert system is tested under several real cases. Finally, an initial evaluation of this expert system is carried out and a positive feedback is received from user's samples, which makes it robust and efficient.**

***Keywords— Expert System; Building House; CLIPS***

## I. INTRODUCTION

An expert system is a computer program designed to simulate the problem-solving behavior of a human who is an expert in a narrow domain or discipline. Expert Systems (ES), also called Knowledge Based System (KBS), are computer application programs that take the knowledge of one or more human experts in a field and computerize it so that it is readily available for use. Expert System makes easier for user to identify the describe symptoms like image bases or textual bases information as it is very difficult to describe in words. It can also be integrated with textual database which can be used for explanation purposes of basic terms and operations to confirm and to reach conclusion in some situations [1].

As a branch of artificial intelligence, an expert system has been widely used. An expert system shell greatly improves the efficiency of the construction of an expert system [2]. Become a computer systems mechanism profound impact on our daily lives as we see every day research and new projects for the use of computers to make life easier and save the experience, and ease the pressure borne by the people? The paper is a mix of the latest techniques presented in this section of the computer science related systems expert systems and decision support, the paper provides scientific material distinguished and easy for the user in the field of architecture in terms of the ability to set the vision and the perception of urban are easy and available, where the idea is based on the establishment of an expert system alternative to the architect be helpful to them in calculating the cost of the construction according to data entered from (The land area, the site of the Earth And,.. etc.), which provides immediate support to customers and make decisions based on information obtained by them and contained them within the scope of existing knowledge has it .

An expert system's knowledge base is traditionally encoded as a set of domain-specific rules. These rules are generally implications of the form:

IF a1 Ù a2 Ù … Ù ak THEN ak+1 Ù ak+2 Ù … Ù an, where the ai's are logical statements that are relevant to the system's problem domain. For example, in the context of soil science, the rule:

IF a soil is sandy and the level of humus is high THEN the soil is compact

The development of expert system is implemented in CLIPS programming environment (C Language Integrated Production System) [3,4,5]. This programming tool is designed to facilitate the development of software to model human knowledge or expertise. CLIPS program is used by reason of the flexibility, the expandability and the low cost.

The outline of the paper is as follows. Section2 problem recognition. Section3 presents the basic of building a house. Section 4 knowledge representation. Section 5 tree knowledge section 6 diagnosis process finally, working example and summarizes this paper.

## II. PROBLEM RECOGNITION

We need to build expert system to presents the design and development of an expert system for Account the Cost of Building House (ACBH). To distribute human expertise in this science.

## III. THE BASIC OF BUILDING A HOUSE

- Choose a place of building a house
- Settlement of the land - soil quality
- Construction area
- Foundations and pillars.
- Types of foundations
- Finished Construction
- Types of buildings
- Types of fossils
- Internal planning for the home
- Determine the labor
- The numbers and types of housing required during the next twenty years in the Kingdom

## IV. KNOWLEDGE REPRESENTATION

The key problem is to find a KR (and a supporting reasoning system) that can make the inferences your application needs in time, that is, within the resource

constraints appropriate to the problem at hand. This tension between the kinds of inferences and application "needs" and what counts as "in time" along with the cost to generate the representation itself makes knowledge representation engineering interesting.

There are representation techniques such as frames, rules, tagging, and semantic networks which have originated from theories of human information processing. Since knowledge is used to achieve intelligent behavior, the fundamental goal of knowledge representation is to represent knowledge in a manner as to facilitate inference (i.e. drawing conclusions) from knowledge [6,7].

Knowledge bases can be represented by production rules. These rules consist of a condition or premise followed by an action or conclusion (IF condition...THEN action).

**For example**

If Land Area 400
and work type foundation
and the number of floors 1
and the number of room 4
and the size of water tank small
Then cost 1,11000 SR

TABLE 1

| Percent% | Number | Types of housing |
|---|---|---|
| 4,23 | 13,812 | Villa |
| 8,04 | 26,267 | Role at Villa |
| 29,8 | 97,438 | Apartment |
| 35,77 | 116,841 | Duplex |
| 22,11 | 72,223 | Mtlasq |
| | 326,581 | Total |

A production rule system consists of

1- A set of rules.
2- Working memory that stores temporary data.
3- A forward or backward chaining inference engine.

**Simple Examples of Represent Rules for Expert System:**

FACT1 cost of the finishing normal1 equal 215,312SR
FACT2 cost of the finishing excellent equal 4,50342SR
FACT4 building foundations1 equal 252,684 SR
FACT5 building foundations2 equal 4,45469 SR
FACT 6 Land area480
FACT 7 Land area400
FACT 8 the number of floor 2
FACT 9 the number of floor 1
FACT 10 water tank small
FACT 11 water tank medium
FACT 12 driver room NO
FACT 13 driver room YES

**RULE 1**

If the land area 480
and cost of building foundations1
and the cost of finishing normal1
and the number of floor 2
Then the overall cost744,279 SR

**RULE 2**

If the land area400
and the number of floor 1
and water tank small
Then the cost of building foundations 6,50432 SR

**RULE 3**

If the Finishing Normal
and driver room NO
and the number of floor 1
Then cost of the finishing 4,34762 SR

To prove the conclusion "the overall cost744, 279 SR" inference engine must prove all condition that leading to this conclusion. Condition can be found from asking user or from another Rule because this condition is conclusion in Rule.

## V. TREE KNOWLEDGE

A decision tree (or tree diagram) is a decision support tool that uses a tree-like graph or model of decisions and their possible consequences, including chance event outcomes, resource costs. Decision trees are commonly used in operations research, specifically in decision analysis, to help identify a strategy most likely to reach a goal. Another use of decision trees is as a descriptive means for calculating conditional probabilities.

We give the example for land area 480 and 400 m square.

First: land area 400 m2

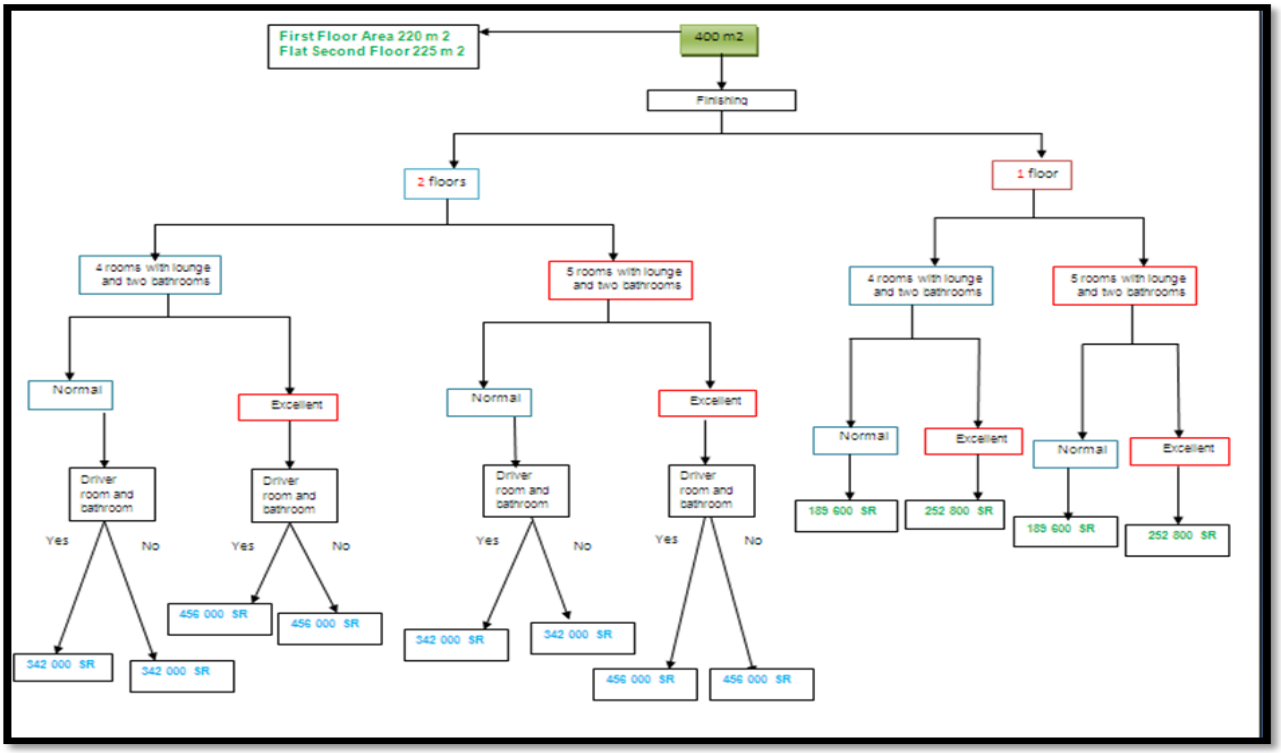


Fig. 1. Tree Knowledge - Foundation

## A. *Foundational*

There are two options to the user in the Foundational, one or two floors.

If chosen for one floor, there are two cases before him to be the internal planning of the house 4 or 5 rooms with kitchen and two bathrooms.

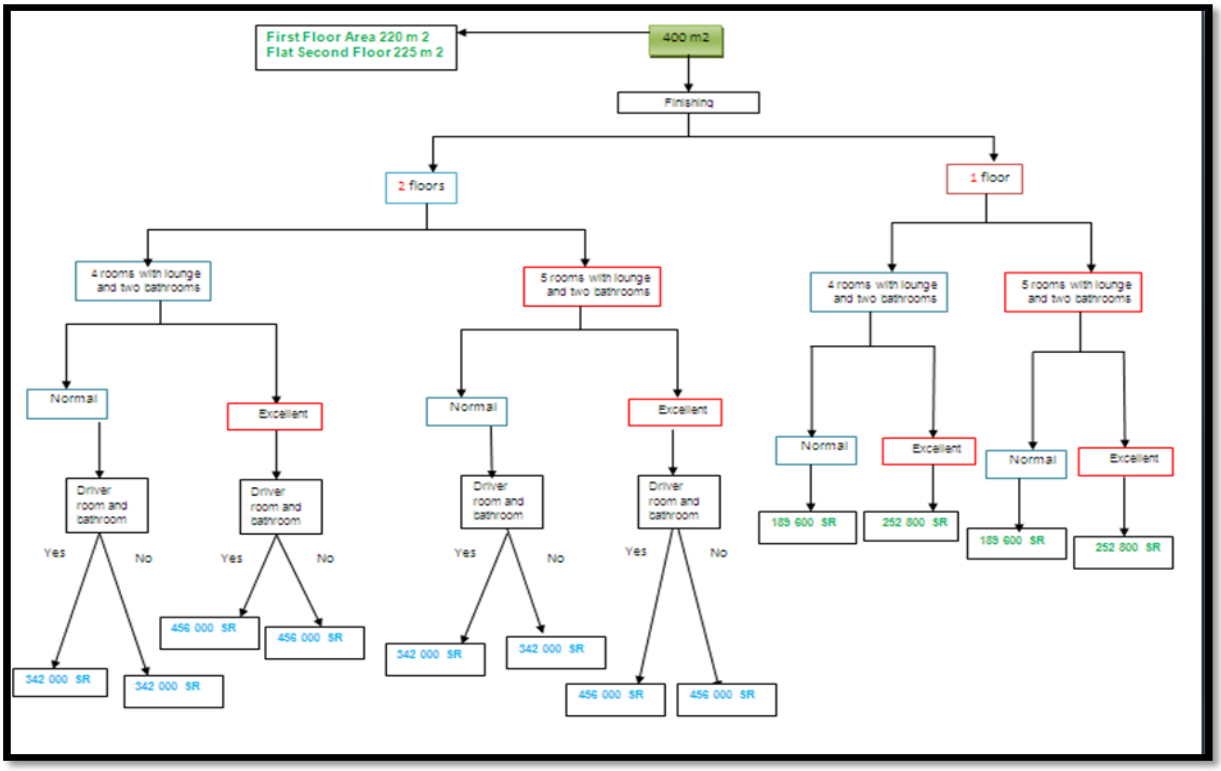


Fig. 2. Tree Knowledge – Finishing

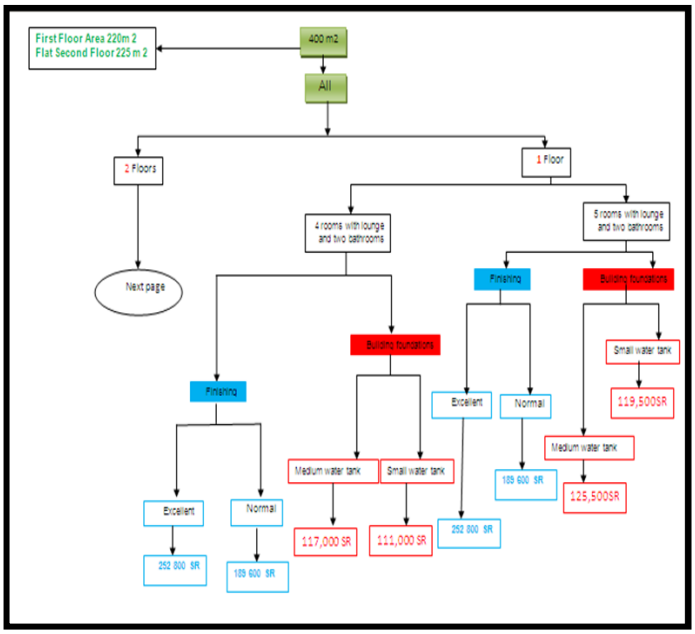


Fig. 3. Tree Knowledge – all- One

Then it will determine the size of tank water.

In the case of the user's choice 2 floors, will pass the same the previous options on one floor, but will start a driver with a bathroom extension, Show this explanation in figure (1).

## B. *Finishing*

If the user chooses the option of calculating the cost of finishing, also given the choice between 1 or 2 floors. Then the internal planning 4 or 5 with kitchen and 2 bathrooms.

We have 2 type of finishing Normal , Excellent every Each type of them has a different cost from one another and are calculated cost them m², Show this explanation in figure (2).

## C. *ALL*

The user select choice All this mean (Foundational and finishing together), then calculate the cost at the same way previous,

Show this explanation in the following figures (3) and (4).

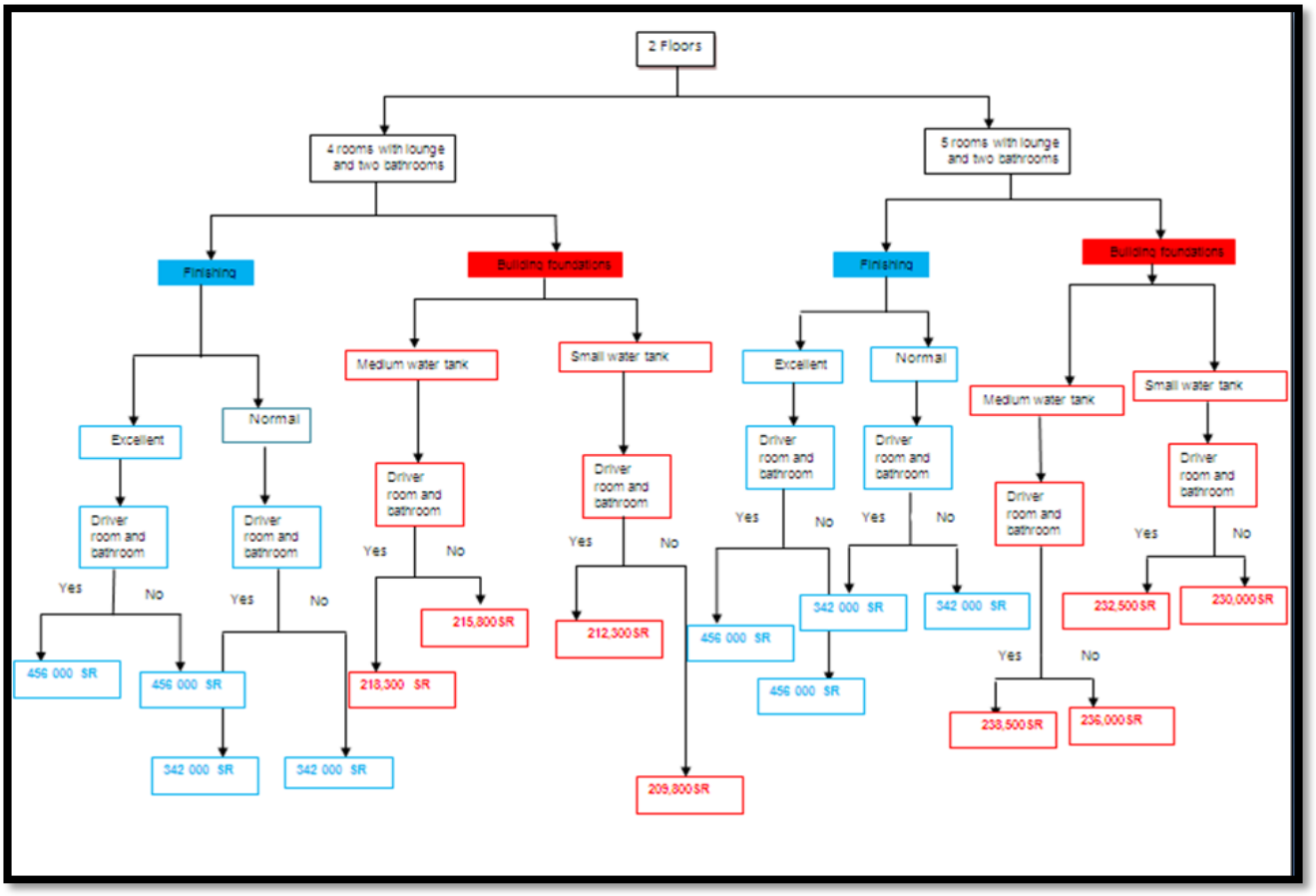


Fig. 4. Tree Knowledge – all- Two floors

## VI. DIAGNOSIS PROCESS

The expert system software adopted C# to deal with the preparatory work, including the maintenance and management. All the status parameters, status values and solutions were obtained from the database access through C#, then past to CLIPS through interface functions that between C# and CLIPS, lastly diagnosed by the program that was built by CLIPS, and meanwhile, the inference information and result were past to and displayed on the interface module, which was programmed by C#.

**Expert System Shell**

CLIPS keep in memory a fact list, a rule list, and an agenda with activations of rules. Facts in CLIPS are simple expressions consisting of fields in parentheses. Groups of facts in CLIPS, usually follow a fact-template, so that to be easy to organize them and thus design simple rules that apply to them. Our expert system contains 100 CLIPS rules. Below, we present the rules for (ACBH).

**Working Example**

We can represent this rule using our representation as follow:

Some instruction in the Clips

```
defrule work_type_process
  =>
(printout t "foundation, finish, all" crlf)
  (bind ?answer (read idata))
  (assert(work_type ?answer))
  (printout t ?work_type)
       (defrule area_process
  =>
  (printout t "land area 400 or 480?" crlf)
  (bind ?answer (read idata))
  (assert(area ?answer)))
  (defrule f1
  (work_type foundation)(area 480)(floor one)(rooms five )(small tank)

  =>

  (printout odata "122342" crlf))

(defrule f2

(work_type foundation)(area 480) (floor one)(rooms five)(medium tank)

=> (printout odata "128342" crlf))
```

Figures 5,6,7,8,9 and 10 present some samples from the proposed expert system forms and menus.

**After Execution**


Fig.5. Start-up program

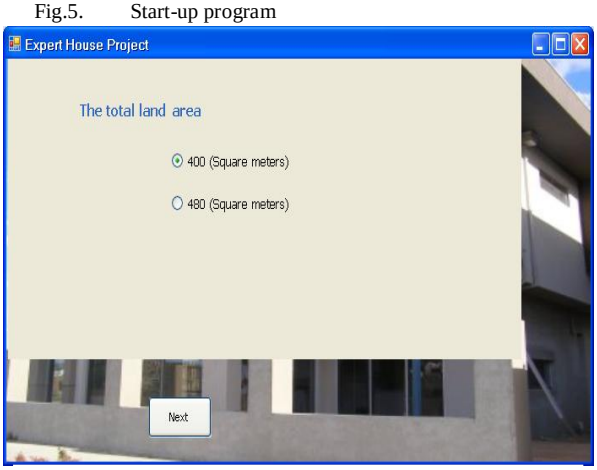


Fig.6. Second screen chose the land area

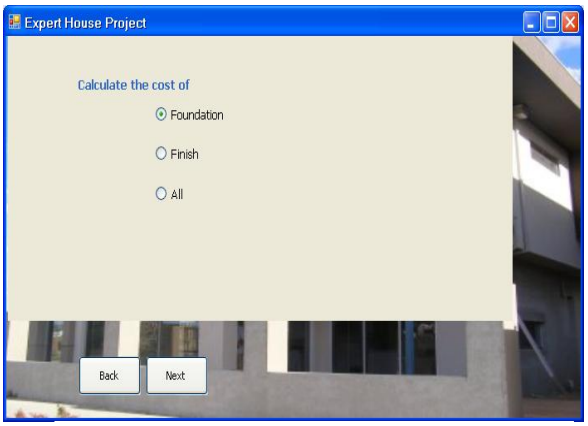


Fig.7. choose the type of work

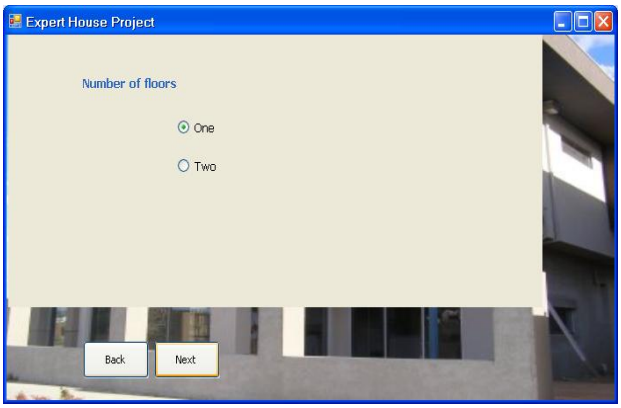


Fig.8. choose the number of floors

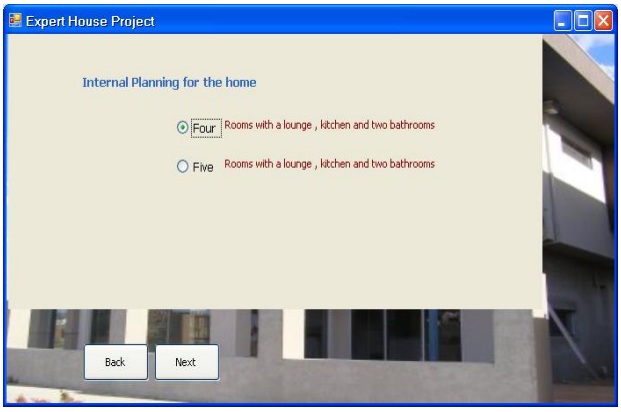


Fig.9. choose the number of rooms

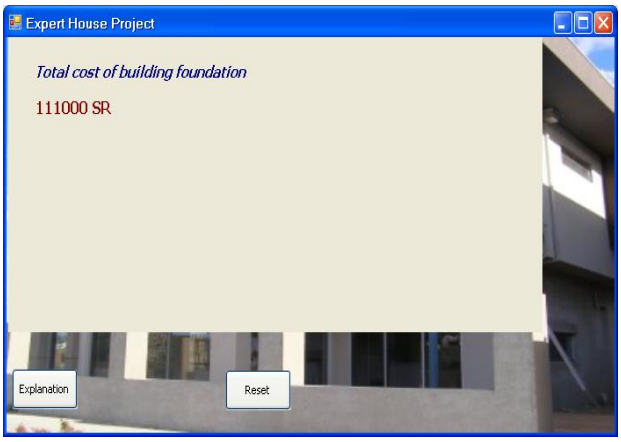


Fig.10. the result of cost SR

## VII. Conclusions

In this paper, the design of an expert system for estimating the Cost of building house is introduced. The expert system is implemented using Clips to build a knowledge base and C # to design a foreground interface. The developed expert system interface is used to receive information from users and handle it under several cases. Accordingly, it returns an accurate estimation to the user. The proposed expert system is included in one executable standalone package. In addition, the proposed expert system test proves that it simple, accurate, powerful, and flexible.

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