Department of Computer Science and Engineering
University of Chittagong

Course: CSE 714 – Artificial Intelligence Lab

Project Title: An Expert System to Assess Heart Disease under Uncertainty

Submitted by:

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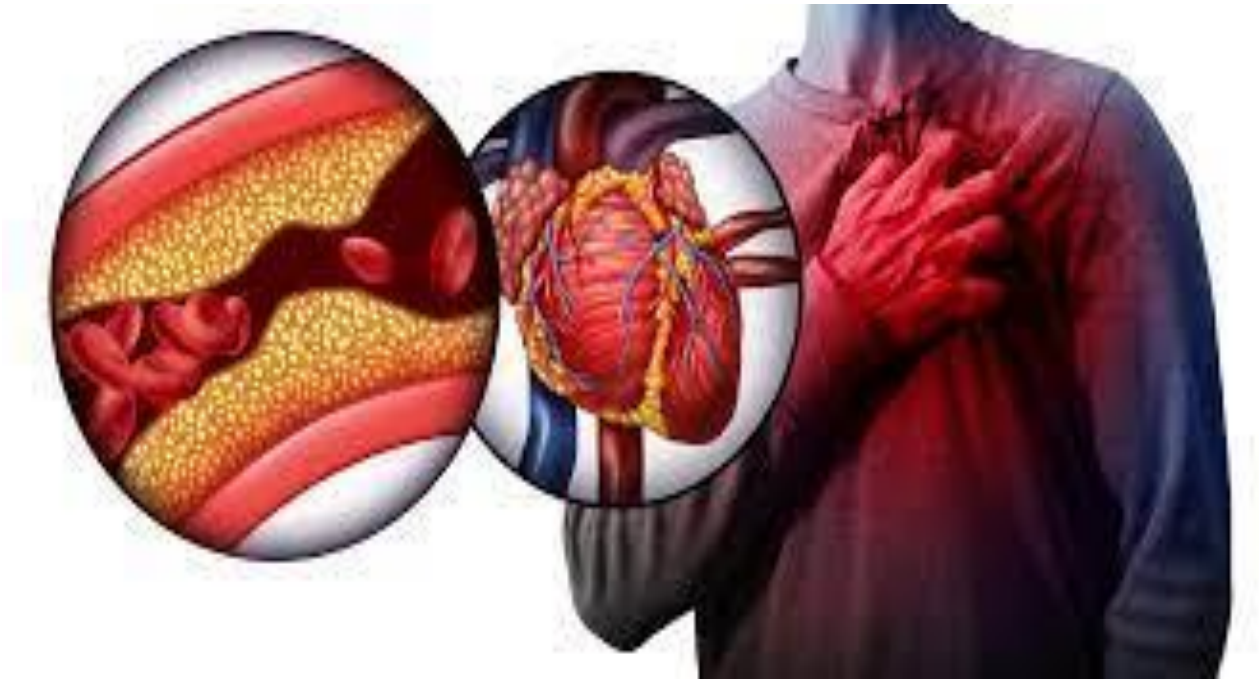
Problem Statement:

Heart disease describes a range of conditions that affect your heart. Diseases under the heart disease umbrella include blood vessel diseases, such as coronary artery disease; heart rhythm problems (arrhythmias); and heart defects you're born with (congenital heart defects), among others. The term "heart disease" is often used interchangeably with the term "cardiovascular disease." Cardiovascular disease generally refers to conditions that involve narrowed or blocked blood vessels that can lead to a heart attack, chest pain (angina) or stroke. Other heart conditions, such as those that affect your heart's muscle, valves or rhythm, also are considered forms of heart disease.



An expert system builds in prolog can identify the type of Heart Disease. It will help a medical system as well as a patient to identify the type of Heart Disease.

Rule Based System:

Rule-based systems (also known as production systems or expert systems) are the simplest form of artificial intelligence. A rule-based system uses rules as the knowledge representation for knowledge coded into the system. The definitions of the rule-based system depend almost entirely on expert systems, which are a system that mimics the reasoning of a human expert in solving a knowledge-intensive problem. Instead of representing knowledge in a declarative, static way as a set of true things, a rule-based system represents knowledge in terms of a set of rules that tells what to do or what to conclude in different situations.

A rule-based system is a way of encoding a human expert's knowledge in a fairly narrow area into an automated system. A rule-based system can be simply created by using a set of assertions and a set of rules that specify how to act on the assertion set. Rules are expressed as a set of if-then statements (called IF-THEN rules or production rules): IF P THEN Q which is also equivalent to $P \Rightarrow Q$. A rule-based system consists of a set of IF-THEN rules, a set of facts, and some interpreters controlling the application of the rules, given the facts.

The idea of an expert system is to use the knowledge from an expert system and encode it into a set of rules. When exposed to the same data, the expert system will perform (or is expected to perform) in a similar manner to the expert. Rule-based systems are very simple models and can be adapted and applied for a large kind of problems. The requirement is that the knowledge of the problem area can be expressed in the form of if-then rules. The area should also not be that large because a high number of rules can make the problem solver (the expert system) inefficient.

Aims and Objectives:

The objectives of my project are

- Helping the users know whether they have heart disease or not, staying at home.
- Also whether the users have any similar kind of disease or not
- Sharing knowledge with mass people
- Creating awareness about Heart Disease
- Making a user-friendly heart disease diagnosis system

Architecture:

The system is based on "Rule Based Architecture". It percepts input from the environment i.e. interacts with the user through a user interface. It takes facts from the database, uses rules defined into the knowledge base and infer an answer. Then it shows the answer to the user.

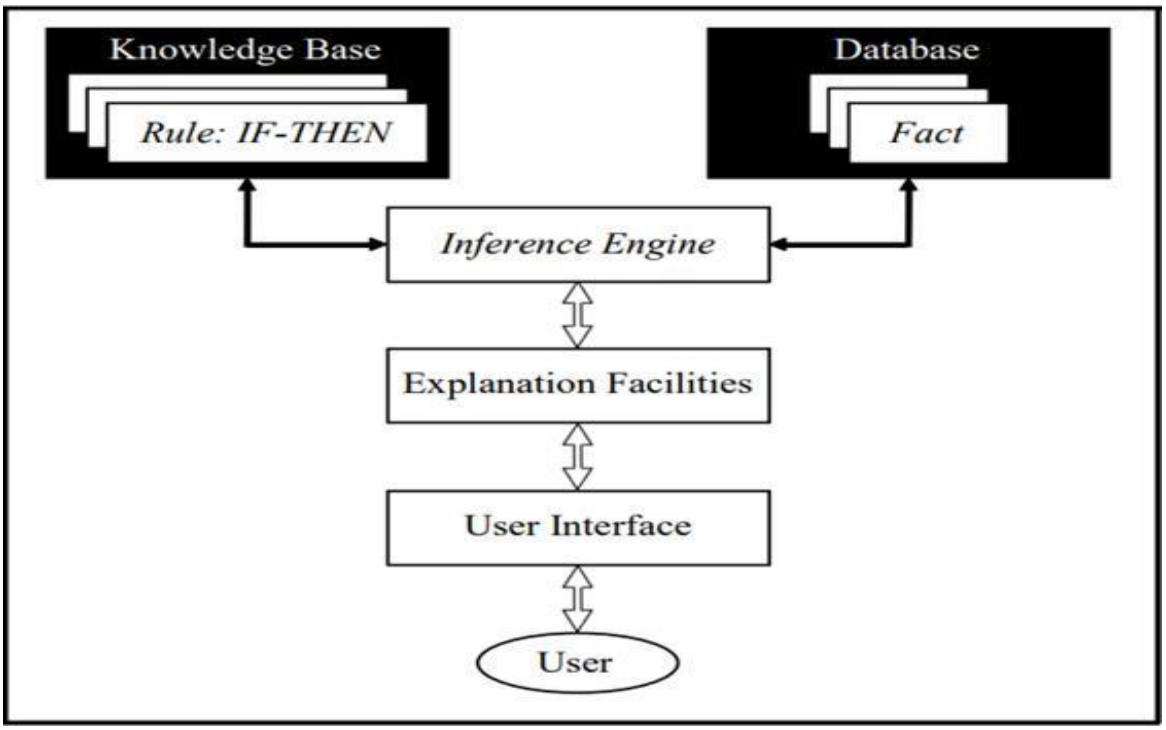


Figure: Architecture of the System

Design:

Design describe how the expert system react according to commands given to prolog environment for identifying the types of Heart Disease. Action performed by the commands is represented in rectangle form and arrows represent direction from one action to another action. In each action user have two answers either yes' or no'.When all conditions are satisfied according to characteristics then it shows the specific types of Heart Disease. Design of expert system is shown in figure-1.

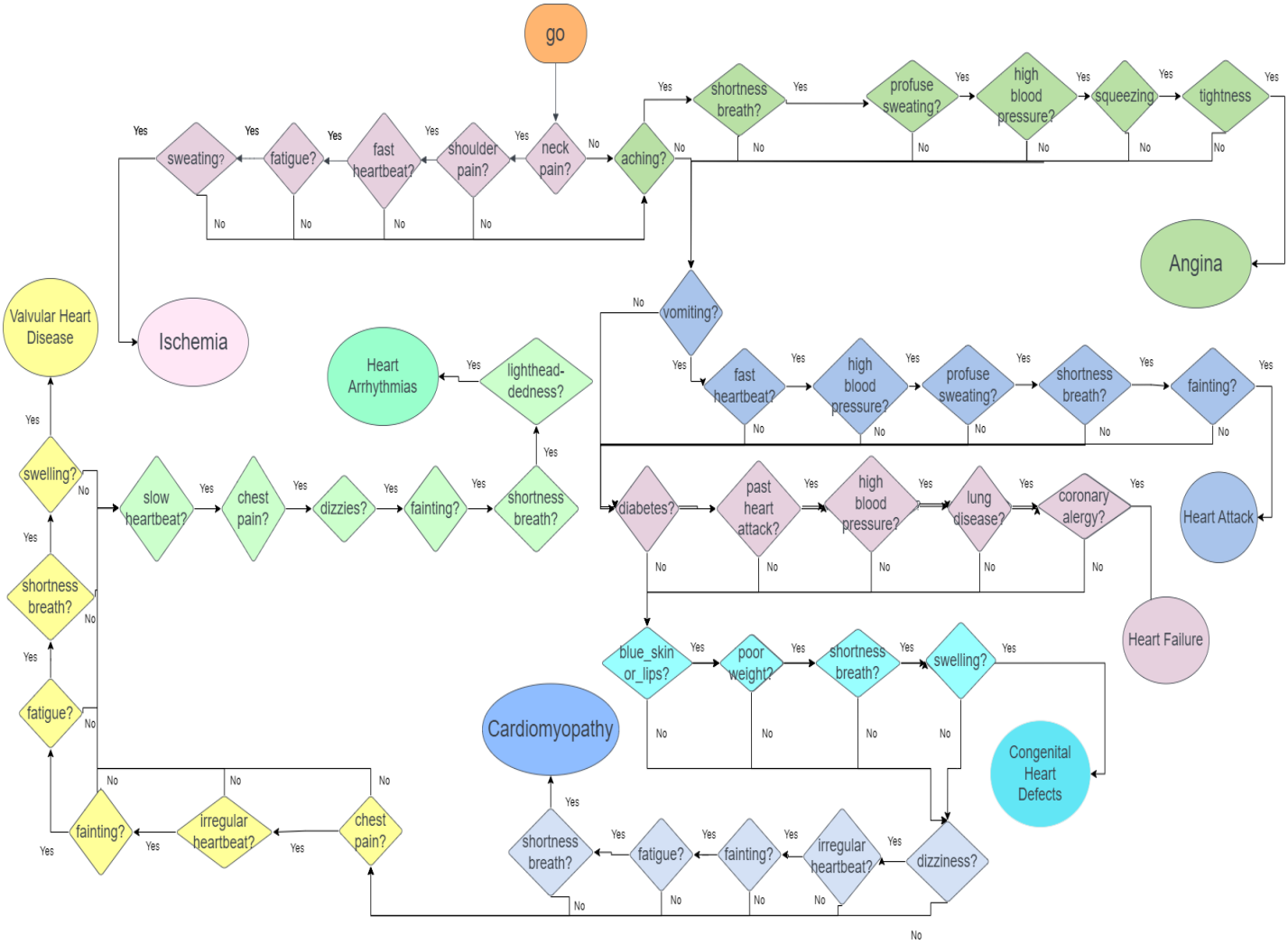


Figure -1

Methodology:

A sample of methodology to diagnose heart disease is given below

Symptom	Ischemia	Angina	Heart Attack	Heart Failure	Congenital Heart Defects	Cardiom-yopathy	Valvular Heart Disease	Heart Arrhyth mias
Neck pain	y							
Shoulder pain	y							
Fast heartbeat	y		y					
fatigue	y					y	y	
sweating	y							
Aching		y						
Shortness breath		y	y		y	y	y	y
Profuse sweating		y	y					
High blood pressure		y	y	y				
Squeezing		y						
Tightness		y						
Vomiting			y					
Fainting			y			y	y	y
Diabetes				y				
Past heart attack				y				
Lung disease				y				
Coronary allergy				y				
Blue skin or lips					y			
Poor weight					y			
swelling					y		y	
Dizziness						y		y
Irregular heartbeat						y	y	
Chest pain							y	y
Slow heart beat								y
Lightheade dness								y

Implementation:

```
domains
   disease,indication = symbol
   patient = string

predicates
   hypothesis(patient,disease)
   symptom(patient,indication)
   response(char)
   go

clauses
   go:-
     write("What is patient's name ?"),
     readln(Patient),
     hypothesis(Patient,Disease),
     write(Patient," probably has ",Disease,"."),nl.


  go:-
    write("Sorry I don’t seem to be able to diagnose the disease"),nl.

   symptom(Patient,neck_pain):-
      write("Does ",Patient," have a neck pain (y/n)? "),
      response(Reply),
      Reply='y'.

   symptom(Patient,shoulder_pain) :-
      write("Does ",Patient," have a shoulder_pain (y/n)?"),
      response(Reply),
      Reply='y'.

   symptom(Patient,fast_heartbeat) :-
      write("Does ",Patient," have a fast heartbeat (y/n)?"),
      response(Reply),
      Reply='y'.

   symptom(Patient,fatigue) :-
      write("Does ",Patient," have a fatigue (y/n)?"),
      response(Reply),
      Reply='y'.

   symptom(Patient,sweating) :-
      write("Does ",Patient,"have a sweating(y/n)?"),
      response(Reply),
      Reply='y'.

   symptom(Patient,aching) :-
      write("Does ",Patient," have aching (y/n)?"),
      response(Reply),
      Reply='y'.
```

```
 symptom(Patient,shortness_breath) :-
      write("Does ",Patient," have a shortness of breath(y/n) ?"),
      response(Reply),
      Reply='y'.

 symptom(Patient,high_blood_presure) :-
      write("Does ",Patient," have a high_blood_presure (y/n) ?"),
      response(Reply),
      Reply='y'.

 symptom(Patient,squeezing) :-
     write("Does ",Patient," have a sueezing(y/n) ?"),
     response(Reply),
     Reply='y'.

 symptom(Patient,tightness) :-
     write("Does ",Patient," have a tightness (y/n) ?"),
     response(Reply),
     Reply='y'.

symptom(Patient,vomiting) :-
     write("Does ",Patient," have a vomiting (y/n) ?"),
     response(Reply),
     Reply='y'.

 symptom(Patient,profase_sweating) :-
     write("Does ",Patient," have profase sweating(y/n)? "),
     response(Reply),
     Reply='y'.

symptom(Patient,fainting) :-
     write("Does ",Patient," have pain and fainting(y/n)? "),
     response(Reply),
     Reply='y'.

symptom(Patient,diabetes) :-
     write("Does ",Patient," have diabetes (y/n)? "),
     response(Reply),
     Reply='y'.

 symptom(Patient,past_heart_attrack) :-
     write("Does ",Patient," have past heart attrack(y/n)? "),
     response(Reply),
     Reply='y'.

 symptom(Patient,lung_disease) :-
     write("Does ",Patient," have lung disease(y/n)? "),
     response(Reply),
     Reply='y'.

symptom(Patient,coronary_alergy) :-
     write("Does ",Patient," have coronary alargy(y/n)? "),
     response(Reply),
```

```
    Reply='y'.

symptom(Patient,blue_skin_or_lips) :-
        write("Does ",Patient," have blue skins or lips(y/n)? "),
        response(Reply),
        Reply='y'.

 symptom(Patient,swelling) :-
        write("Does ",Patient," have Swelling in the legs or around eyes(y/n)? "),
        response(Reply),
        Reply='y'.

 symptom(Patient,poor_weight) :-
        write("Does ",Patient," leading to Poor weights(y/n)? "),
        response(Reply),
        Reply='y'.

 symptom(Patient,irregular_heartbeat) :-
        write("Does ",Patient," suffer irregular heratbeats(y/n) ?"),
        response(Reply),
         Reply='y'.

 symptom(Patient,chest_pain) :-
        write("Does ",Patient," have chest pain(y/n) ?"),
        response(Reply),
        Reply='y'.


 symptom(Patient,dizziness) :-
        write("Does ",Patient," have dizziness(y/n) ?"),
        response(Reply),
        Reply='y'.

 symptom(Patient,slow_heartbeat) :-
        write("Does ",Patient," have slow heart beat(y/n) ?"),
        response(Reply),
        Reply='y'.

 symptom(Patient,lightheadedness) :-
        write("Does ",Patient," have lightheadedness(y/n) ?"),
        response(Reply),
        Reply='y'.


hypothesis(Patient,ischemia):-
  symptom(Patient,neck_pain),
  symptom(Patient,shoulder_pain),
  symptom(Patient,fast_heartbeat),
  symptom(Patient,fatigue),
  symptom(Patient,sweating).

hypothesis(Patient,angina):-
  symptom(Patient,aching),
```

```
    symptom(Patient,shortness_breath),
    symptom(Patient,profuse_sweating),
    symptom(Patient,high_blood_presure),
    symptom(Patient,squeezing),
    symptom(Patient,tightness).

hypothesis(Patient,heart_attrack):-
    symptom(Patient,vomiting),
    symptom(Patient,fast_heartbeat),
    symptom(Patient,high_blood_presure),
    symptom(Patient,profuse_sweating),
    symptom(Patient,shortness_breath),
    symptom(Patient,fainting).

hypothesis(Patient,heart_failure):-
    symptom(Patient,diabetes),
    symptom(Patient,past_heart_attrack),
    symptom(Patient,high_blood_presure),
    symptom(Patient,lung_disease),
    symptom(Patient,coronary_alergy).

hypothesis(Patient,congenital_heart_defects):-
    symptom(Patient,blue_skin_or_lips),
    symptom(Patient,poor_weight),
    symptom(Patient,shortness_breath),
    symptom(Patient,swelling).

hypothesis(Patient,cardiomyopathy):-
    symptom(Patient,dizziness),
    symptom(Patient,irregular_heartbeat),
    symptom(Patient,fainting),
    symptom(Patient,fatigue),
    symptom(Patient,shortness_breath).

hypothesis(Patient,valvular_heart_disease):-
    symptom(Patient,chest_pain),
    symptom(Patient,irregular_heartbeat),
    symptom(Patient,fainting),
    symptom(Patient,fatigue),
    symptom(Patient,shortness_breath),
    symptom(Patient,swelling).

hypothesis(Patient,heart_arrhythmias):-
    symptom(Patient,slow_heartbeat),
    symptom(Patient,chest_pain),
    symptom(Patient,dizziness),
    symptom(Patient,fainting),
    symptom(Patient,shortness_breath),
    symptom(Patient,lightheadedness).

response(Reply) :-
    readchar(Reply),
write(Reply),nl.
```

Dialogue modules

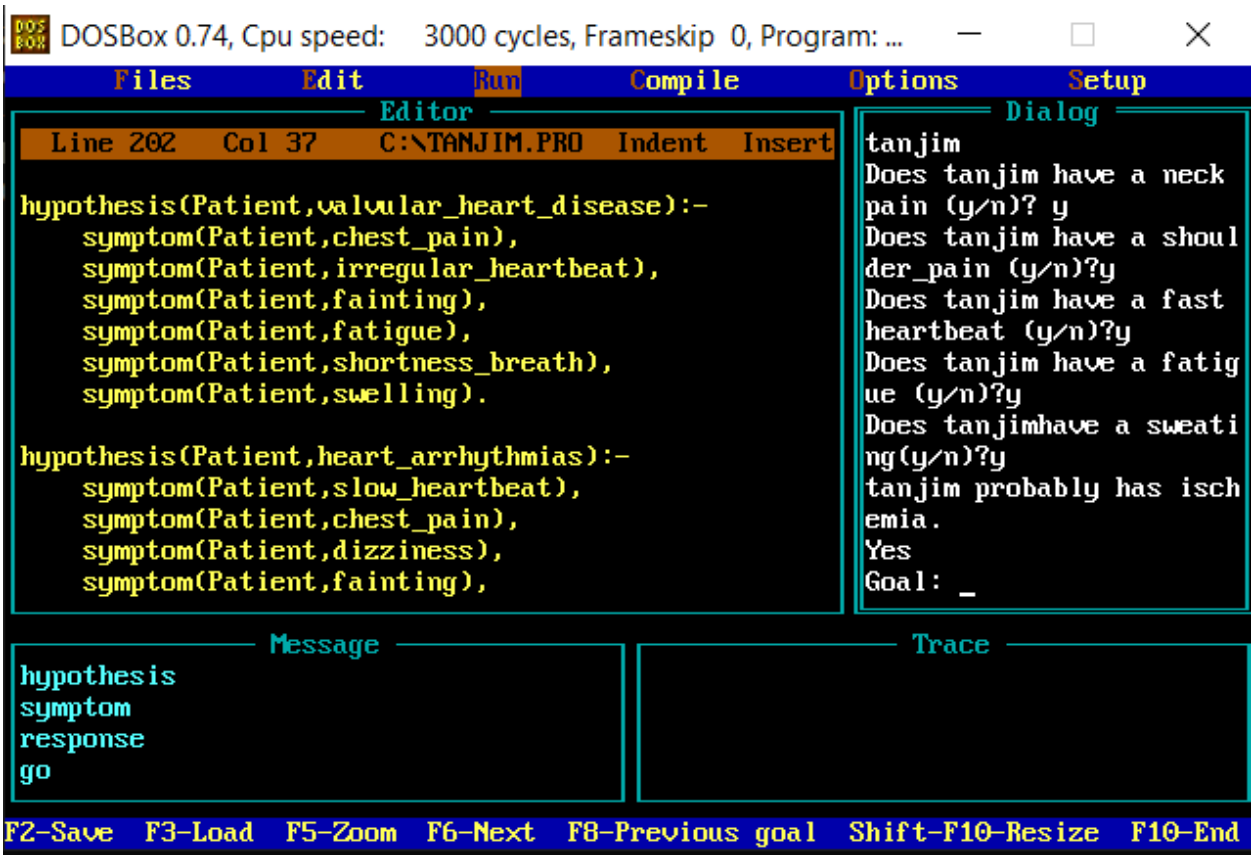
Some of the goal processes of turbo prolog is demonstrated in Table 1 below. This is how the user will be asked a series of yes/no questions where yes means the user has those symptoms otherwise the user answers no. yes/no is the input to the system by the user.

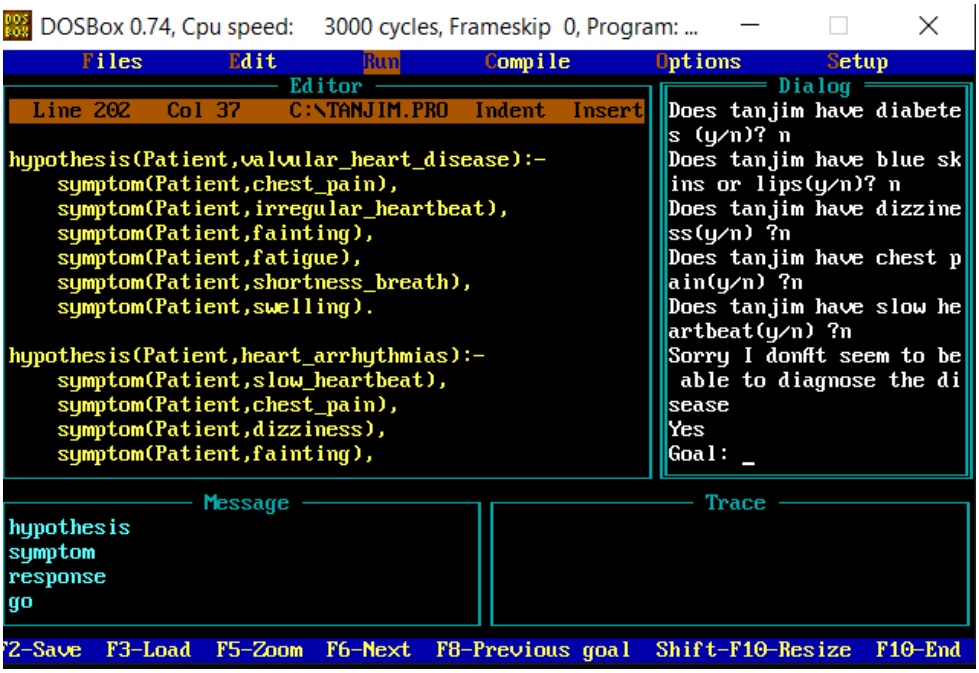
User	**Dialogue**
system	Do you have a neck pain (yes/no) ?
User	Yes/No
system	Do you have a shoulder pain (yes/no) ?
User	Yes/No
system	Do you have a fast heartbeat (yes/no) ?
User	Yes/No
system	Do you have a fatigue (yes/no) ?
User	Yes/No
system	Do you have a sweating (yes/no) ?
User	Yes/No
system	Do you have aching (yes/no) ?
User	Yes/No
System	Do you have a high blood pressure (yes/no) ?
User	Yes/No
System	Do you have a sueezing (yes/no) ?
User	Yes/No
System	Do you have a tightness (yes/no) ?
User	Yes/No

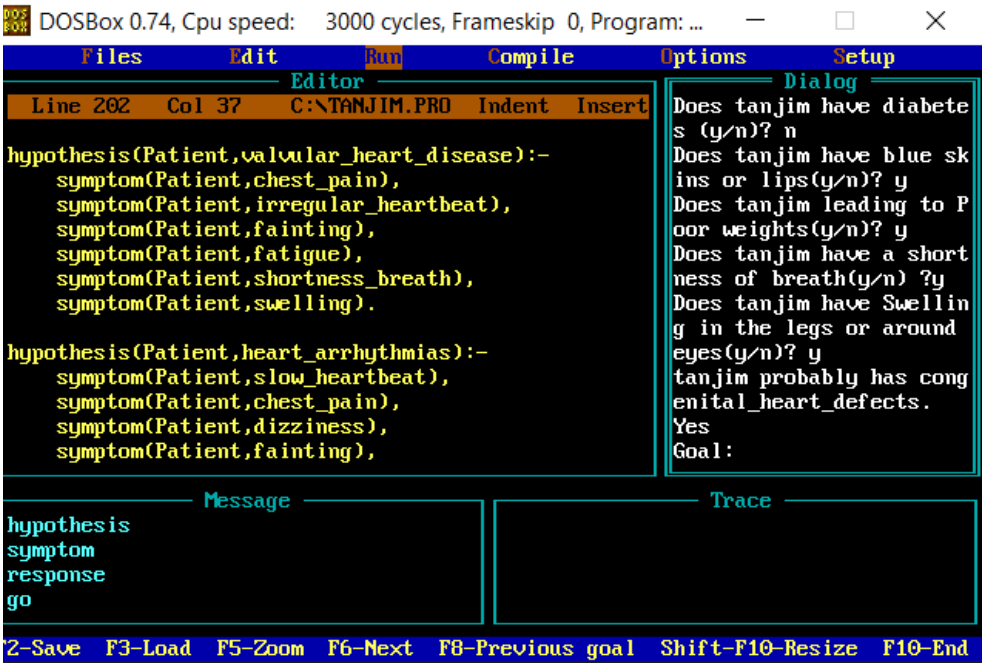
System	Do you have a vomiting (yes/no) ?
User	Yes/No
System	Do you have diabetes (yes/no) ?
User	Yes/No
System	Do you have past heart attack (yes/no) ?
User	Yes/No
System	Do you have lung disease (yes/no) ?
User	Yes/No
System	Do you have coronary allergy (yes/no) ?
User	Yes/No
System	Do you have Chest pain (yes/no) ?
User	Yes/No
System	Do you have irregular heartbeat (yes/no) ?
User	Yes/No
System	Do you have slow heartbeat (yes/no) ?
User	Yes/No
System	Do you have swelling in legs or around eyes (yes/no) ?
User	Yes/No
System	Do you have dizziness (yes/no) ?
User	Yes/No
System	Do you have lightheadedness (yes/no) ?
User	Yes/No

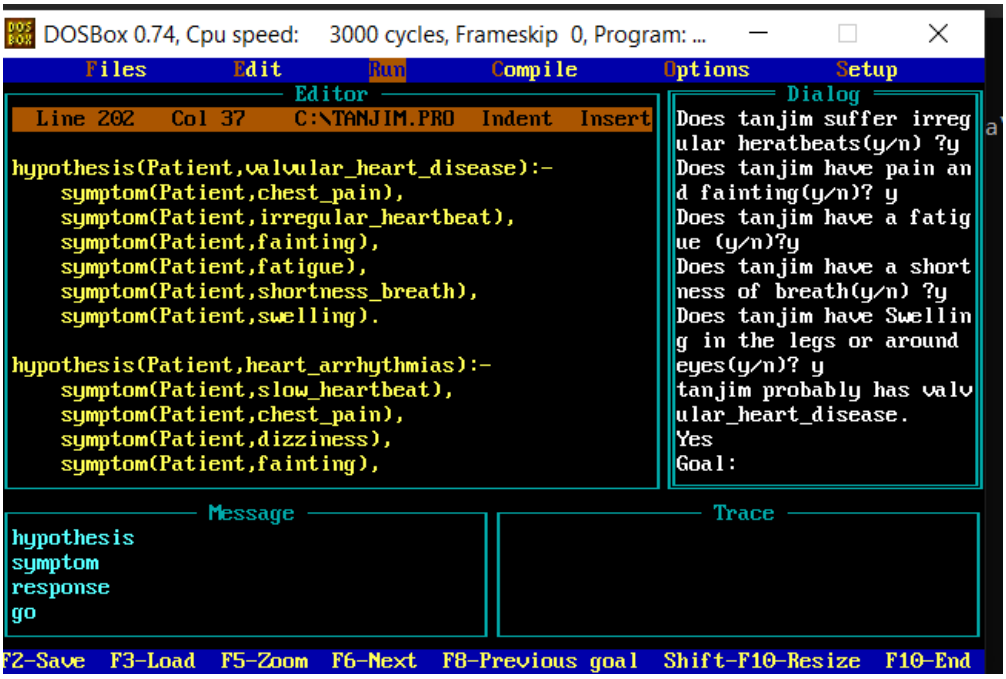
Snapshots:

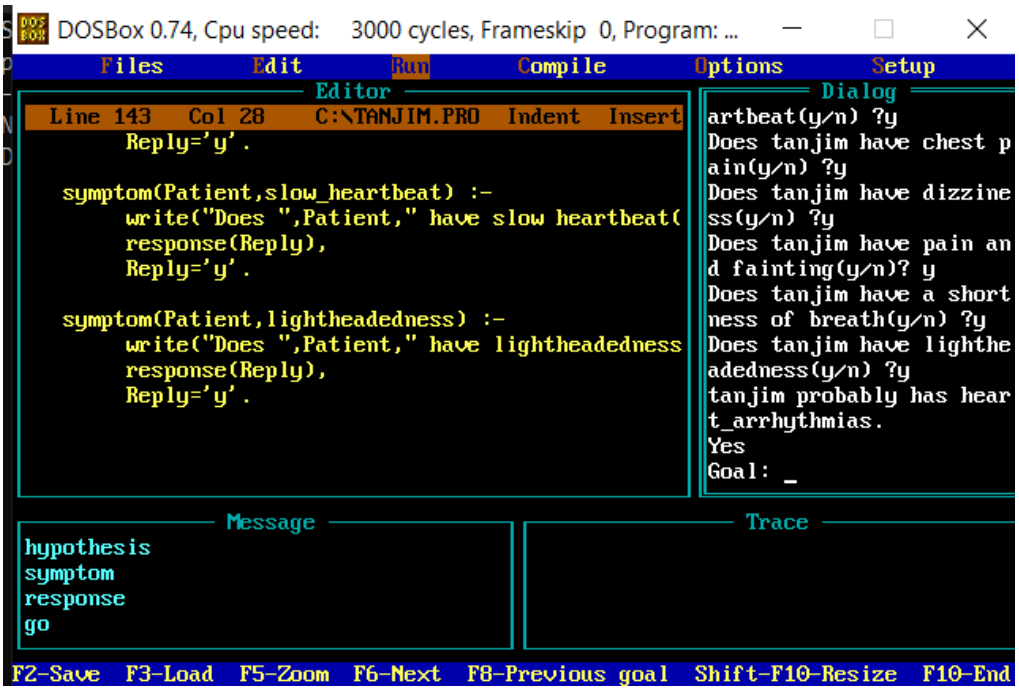
The system was developed on prolog using DOSBOX. Some snapshots of the whole process is given below:




DOSBox 0.74, Cpu speed: 3000 cycles, Frameskip 0, Program: ...
Files Edit Run Compile Options Setup
Editor
Line 202 Col 37 C:\TANJIM.PRO Indent Insert
hypothesis(Patient,valvular_heart_disease):-
symptom(Patient,chest_pain),
symptom(Patient,irregular_heartbeat),
symptom(Patient,fainting),
symptom(Patient,fatigue),
symptom(Patient,shortness_breath),
symptom(Patient,swelling).
hypothesis(Patient,heart_arrhythmias):-
symptom(Patient,slow_heartbeat),
symptom(Patient,chest_pain),
symptom(Patient,dizziness),
symptom(Patient,fainting),
Dialog
Does tanjim have diabete
s (y/n)? n
Does tanjim have blue sk
ins or lips(y/n)? n
Does tanjim have dizzine
ss(y/n) ?n
Does tanjim have chest p
ain(y/n) ?n
Does tanjim have slow he
artbeat(y/n) ?n
Sorry I donAt seem to be
able to diagnose the di
sease
Yes
Goal:
Message
hypothesis
symptom
response
go
Trace
F2-Save F3-Load F5-Zoom F6-Next F8-Previous goal Shift-F10-Resize F10-End


DOSBox 0.74, Cpu speed: 3000 cycles, Frameskip 0, Program: ...
Files Edit Run Compile Options Setup
Editor
Line 202 Col 37 C:\TANJIM.PRO Indent Insert
hypothesis(Patient,valvular_heart_disease):-
symptom(Patient,chest_pain),
symptom(Patient,irregular_heartbeat),
symptom(Patient,fainting),
symptom(Patient,fatigue),
symptom(Patient,shortness_breath),
symptom(Patient,swelling).
hypothesis(Patient,heart_arrhythmias):-
symptom(Patient,slow_heartbeat),
symptom(Patient,chest_pain),
symptom(Patient,dizziness),
symptom(Patient,fainting),
Dialog
Does tanjim have diabete
s (y/n)? n
Does tanjim have blue sk
ins or lips(y/n)? y
Does tanjim leading to P
oor weights(y/n)? y
Does tanjim have a short
ness of breath(y/n) ?y
Does tanjim have Swellin
g in the legs or around
eyes(y/n)? y
tanjim probably has cong
enital_heart_defects.
Yes
Goal:
Message
hypothesis
symptom
response
go
Trace
F2-Save F3-Load F5-Zoom F6-Next F8-Previous goal Shift-F10-Resize F10-End


DOSBox 0.74, Cpu speed: 3000 cycles, Frameskip 0, Program: ...
Files Edit Run Compile Options Setup
Editor
Line 202 Col 37 C:\TANJIM.PRO Indent Insert
hypothesis(Patient,valvular_heart_disease):-
symptom(Patient,chest_pain),
symptom(Patient,irregular_heartbeat),
symptom(Patient,fainting),
symptom(Patient,fatigue),
symptom(Patient,shortness_breath),
symptom(Patient,swelling).
hypothesis(Patient,heart_arrhythmias):-
symptom(Patient,slow_heartbeat),
symptom(Patient,chest_pain),
symptom(Patient,dizziness),
symptom(Patient,fainting),
Dialog
Does tanjim suffer irreg
ular heratbeats(y/n) ?y
Does tanjim have pain an
d fainting(y/n)? y
Does tanjim have a fatig
ue (y/n)?y
Does tanjim have a short
ness of breath(y/n) ?y
Does tanjim have Swellin
g in the legs or around
eyes(y/n)? y
tanjim probably has valv
ular_heart_disease.
Yes
Goal:
Message
hypothesis
symptom
response
go
Trace
F2-Save F3-Load F5-Zoom F6-Next F8-Previous goal Shift-F10-Resize F10-End


DOSBox 0.74, Cpu speed: 3000 cycles, Frameskip 0, Program: ...
Files Edit Run Compile Options Setup
Editor
Line 143 Col 28 C:\TANJIM.PRO Indent Insert
Reply='y'.
symptom(Patient,slow_heartbeat) :-
write("Does ",Patient," have slow heartbeat(
response(Reply),
Reply='y'.
symptom(Patient,lightheadedness) :-
write("Does ",Patient," have lightheadedness
response(Reply),
Reply='y'.
Dialog
artbeat(y/n) ?y
Does tanjim have chest p
ain(y/n) ?y
Does tanjim have dizzine
ss(y/n) ?y
Does tanjim have pain an
d fainting(y/n)? y
Does tanjim have a short
ness of breath(y/n) ?y
Does tanjim have lighthe
adedness(y/n) ?y
tanjim probably has hear
t_arrhythmias.
Yes
Goal: _
Message
hypothesis
symptom
response
go
Trace
F2-Save F3-Load F5-Zoom F6-Next F8-Previous goal Shift-F10-Resize F10-End

Conclusion:

The prolog program that I built is very simple to use and efficient. It's pretty accurate too. This expert system has been typically designed to provide capabilities similar to those of a human expert when performing a task. The program asks a few yes/no questions to the user to note down which symptoms the user is facing. Then after knowing all the symptoms that the user is facing the expert system searches up on its knowledge base and then generates the most probable answer i.e. in this case the Heart Disease type.

It is to be noted that the knowledge base is also accompanied with an interference base. Thus the expert system is more enriched and learns from experience bit by bit. This work can be extended by

- Adding more realistic rules and facts
- Including suggestions on foods and medicines