

Study and Analysis of MYCIN expert system

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Abstract: MYCIN was the one of the initial expert systems to perform with the level of expertise of a human expert and to provide users with complete explanation of its logical reasoning. MYCIN played a benchmark of most of the expert systems which were developed after MYCIN. Moreover, the techniques which were developed for MYCIN expert system have become most widely available design in the various small expert system building tools. It was designed to aid doctors in proper diagnosis and treatment of bacteremia infections. MYCIN was strictly a research system. The present paper provides summary of rule application concepts of MYCIN expert system.

Introduction

MYCIN is an expert system. By that we mean that it is an AI program designed (a) to provide expert level solutions to complex problems, (b) to be understandable, and (c) to be flexible enough to accommodate new knowledge easily. Because we have designed MYCIN to provide advice through a consultative dialogue, we sometimes refer to it as a consultation system[10][11].

There are two main parts to an expert system like MYCIN: a knowledge base and an inference mechanism, or engine (Figure 1-1). In addition there are often subprograms designed to facilitate interaction with users, to help build a knowledge base, to explain a line of reasoning, and so forth^[10].

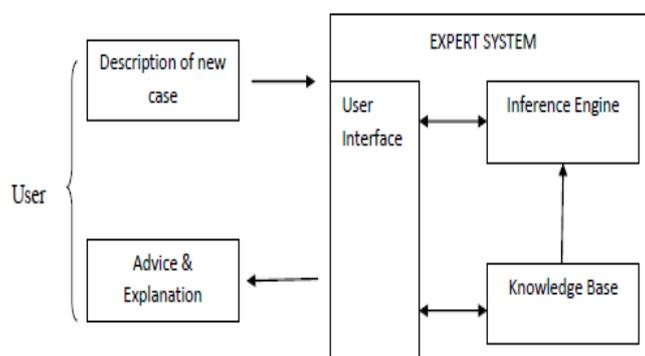


Figure 1.1 Major Parts of an expert system.
Arrows indicate information flow^[2].

The knowledge base is the program's store of facts and associations it "knows" about a subject area such as medicine. A critical design decision is how such knowledge is to be represented within the program. There are many choices, in general. For MYCIN, we chose to represent knowledge mostly as conditional statements, or rules, of the following form^{[2][10][11]}:

IF: There is evidence that A and B are true,

THEN: Conclude there is evidence that C is true.

This form is often abbreviated to one of the following:

IF A and B, then C

A & B ->C

We refer to the antecedent of a rule as the premise or left-hand side (LHS) and to the consequent as the action or right-hand side (RHS).

The interference mechanism can take many forms. We often speak of the control structure or control of inference to reflect the fact that there are different controlling strategies for the system. For example, a set of rules may be chained together, as in this example:

If A, then B (Rule 1)

If B, then C (Rule 2)
A (Data)
 C (Conclusion)

This is sometimes called forward chaining, or data directed inference, because the data that are known (in the case A) drive the inferences from left to right in rules, with rules chaining together to deduce a conclusion (C) [10].

MYCIN primarily uses backward chaining, or a goal-directed control strategy. The deductive validity of the argument is established in the same way, but the system's behavior is quite different. In goal directed reasoning a system starts with a statement of the goal to achieve and works "backward" through inference rules, i.e., from right to left, to find the data that establish that goal, for example:

Find out about C
 (Goal)

1) If B, then C (Rule)

2) If A, then B (Rule)

If A, then C
 (Implicit rule)

Question: Is A true?
 (Data)

MYCIN contains an explanation subsystem, for example, which explains the reasoning of the performance system.

The process of mapping an expert's knowledge into a program's knowledge base as knowledge engineering. The intended users of these kinds of tools are either (a) the so-called knowledge engineers who help an expert formulate and represent domain-specific knowledge for the performance system or (b) the experts themselves. Although either group might also run the performance system to test it, neither overlaps with

the intended routine users of the performance system.

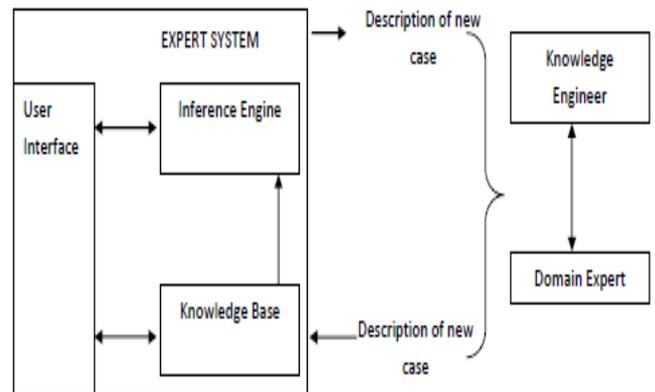
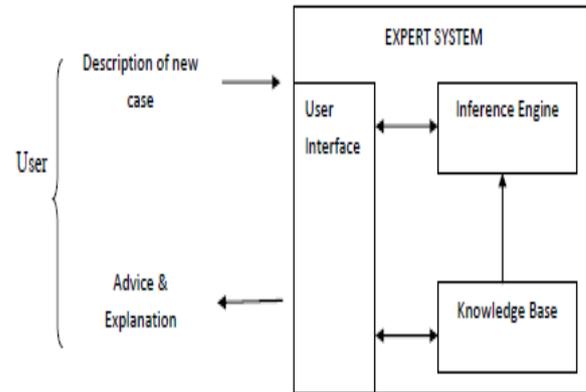


Figure:1.2 Interaction of a knowledge engineer and domain expert with software tools that aid in building an expert system. Arrows indicate information flow.

MYCIN's Task Domain - Antimicrobial Selection

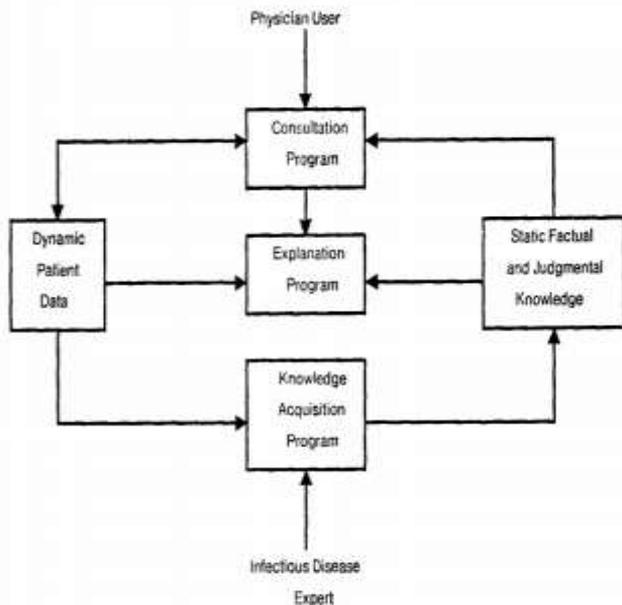
Because a basic understanding of MYCIN's task domain is important for understanding much of what follows, we include here a brief description of infectious disease diagnosis and therapy.

- **The Nature of the Decision Problem**
 - Is the Infection Significant?
 - What is the Organism's Identity?
 - What are the Potentially Useful Drugs?
 - Which Drug Is Best for This Patient?

The Structure of the MYCIN System^[3]

The MYCIN system comprises three major subprograms, as depicted in Figure. The

Consultation Program is the core of the system; it interacts with the physician to obtain information about the patient, generating diagnoses and therapy recommendations. The Explanation Program provides explanations and justifications for the program's actions. The Knowledge-Acquisition Program is used by experts to update the system's knowledge base.



Consultation Program

Excerpts from a sample consultation are shown in following data. The doctor's responses are in upper-case letters following the double-asterisk prompt. Considerable effort has gone into the human engineering aspects of the system, to make the interaction as smooth as possible. If the user finds a question unclear, he or she can request a rephrasing with a list of sample responses. A large dictionary of synonyms allows the user great latitude in choice of responses, and simple typing or spelling errors are automatically corrected.

- 1) Patient's name: (first-last) ** Ankur Meena
- 2) Sex: **M
- 3) Age: ** 25
- 4) Are there any cultures for Ankur which may be related to the present illness, and from which organisms have been grown successfully in the microbiology laboratory? **y CULTURE-1

- 5) From what site was the specimen for CULTURE-1 taken? ** BLOOD
- 6) Please give the date and time when CULTURE-1 was obtained. (mo/da/yr time) ** Aug 20, 2015
The first organism isolated from the blood culture of Aug 20, 2015 (CULTURE-I) will be referred to as: ORGANISM-1
- 7) Enter the laboratory-reported identity of ORGANISM-I: **UNKNOWN
- 8) The stain of ORGANISM-I: ** NEG
- 9) The type of ORGANISM-I: ** XYZ
- 10) What is the form of the individual organisms (e.g. lancetshaped for cocci, fusiform for rods, etc.)? ** FUSIFORM

(Questions 1-3 request background patient data.)
(System corrects typing error.) (Typically identity is not yet known.) (Preliminary lab results give some clues.)

(... more questions follow in order to gather sufficient information to infer the identity and significance of the infecting organisms...)

- 24) Is Ankur a burn patient? **N
- 25) Is Ankur a compromised host (e.g. alcoholic, chain smoker, immunosuppressed)? **N

... after about 50-50 questions, MYCIN prints the diagnostic hypotheses on which therapy will be based...). Therapy recommendations will be designed to treat for organisms that are either very likely or, although less likely, would have a significant effect on therapy selection if they were present. It is important to cover for the probable infection(s) and associated organism(s).

... questions follow to evaluate possible therapy choices, and finally MYCIN prints its therapy recommendations...)

[REC-t] Preferred therapy recommendations as follows: In order to cover for items :

Give: Crocin(500 mg, twice a day)
Alerid-d(twice a day)

Comments: Modify dose in renal problem.

Decision Rules^[3]

Automated problem-solving systems use criteria for drawing conclusions that often support a direct analogy to the rule-based knowledge representation used by MYCIN.

Consider, for example, the conditional probabilities that underlie Bayesian diagnosis programs. Each probability provides information that may be stated in an explicit rule format:

$$P(h|e) = X$$

means

IF: e is known to be true

THEN: conclude that h is true with probability X

It is important to note, therefore, that the concept of rule-based knowledge is not unique, even for medical decision-making programs.

MYCIN's Control Structure^[3]

MYCIN's task involves a four-stage decision problem:

1. Decide which organisms, if any, are causing significant disease.
2. Determine the likely identity of the significant organisms.
3. Decide which drugs are potentially useful.
4. Select the best drug or drugs.

A consultation session with MYCIN results from a simple two-step procedure:

- Create the patient context as the top node in the context tree.
- 2. Attempt to apply the goal rule to the newly created patient context. After the second step, the consultation is over. Thus we must explain how the simple attempt to apply the goal rule to the patient causes a lengthy consultation with an individualized reasoning chain.

Conclusions

The paper provides us general overview of part of rule application module of MYCIN. In the paper a small example has been taken for demonstrating general input and application. In the paper general components of expert systems i.e. MYCIN are shown with special emphasis of rule application.

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