

- The system must be able to justify that its answer is correct, particularly when it is giving advice to a human.
- The same features can be used for explanation and for debugging the knowledge base.
- There are three main mechanisms:
  - ▶ Ask HOW a goal was derived.
  - ▶ Ask WHYNOT a goal wasn't derived.
  - ▶ Ask WHY a subgoal is being proved.

# How did the system prove a goal?

- If  $g$  is derived, there must be a rule instance

$$g \Leftarrow a_1 \& \dots \& a_k.$$

where each  $a_i$  is derived.

- If the user asks HOW  $g$  was derived, the system can display this rule. The user can then ask

*HOW  $i$ .*

to give the rule that was used to prove  $a_i$ .

- The HOW command moves down the proof tree.

# Why Did the System Ask a Question?

It is useful to find out why a question was asked.

- Knowing why a question was asked will increase the user's confidence that the system is working sensibly.
- It helps the knowledge engineer optimize questions asked of the user.
- An irrelevant question can be a symptom of a deeper problem.
- The user may learn something from the system by knowing why the system is doing something.

- When the system asks the user a question  $g$ , the user can reply with

WHY

- This gives the instance of the rule

$$h \Leftarrow \dots \& g \& \dots$$

that is being tried to prove  $h$ .

- When the user asks WHY again, it explains why  $h$  was proved.

There are four types of nonsyntactic errors that can arise in rule-based systems:

- An incorrect answer is produced; that is, some atom that is false in the intended interpretation was derived.
- Some answer wasn't produced; that is, the proof failed when it should have succeeded, or some particular true atom wasn't derived.
- The program gets into an infinite loop.
- The system asks irrelevant questions.

# Debugging Incorrect Answers

- An **incorrect answer** is a derived answer which is false in the intended interpretation.
- An incorrect answer means a clause in the KB is false in the intended interpretation.
- If  $g$  is false in the intended interpretation, there is a proof for  $g$  using  $g \Leftarrow a_1 \& \dots \& a_k$ . Either:
  - ▶ Some  $a_i$  is false: debug it.
  - ▶ All  $a_i$  are true. This rule is buggy.

- **WHYNOT**  $g$ .  $g$  fails when it should have succeeded.

**Either:**

- ▶ There is an atom in a rule that succeeded with the wrong answer, use HOW to debug it.
- ▶ There is an atom in a body that failed when it should have succeeded, debug it using WHYNOT.
- ▶ There is a rule missing for  $g$ .

# Debugging Infinite Loops

- There is no automatic way to debug all such errors: **halting problem.**
- There are many errors that can be detected:
  - ▶ If a subgoal is identical to an ancestor in the proof tree, the program is looping.
  - ▶ Define a well-founded ordering that is reduced each time through a loop.