COSC 370 – Artificial Intelligence
Project 4

Purpose: Implement a query system utilizing first-order logic and backward-chaining.

PART 1 Task (75%): Dr. Ernest Beakerman has been experimenting with gene knockout mice for the last 10 years. Recently he has had a major breakthrough with his KM-52a strain. It turns out that the mice are hyper intelligent and possess a keen grasp of logic far superior to any humans. Since mice by their nature are quite friendly, the KM-52a mice have employed themselves to bettering humanity. For instance, Algernon II is now advising the president on foreign matters and has figured out ways of creating peace across the world and curing cancer.

The problem with KM-52a is that like all other mice, they live at most 4 years. As a result, new generations must be constantly trained to replace the current mice, which die off very quickly. Additionally, they must be trained with great speed so that they can spend as much time as possible aiding humanity into a new era of prosperity.

Dr. Beakerman has employed you in his lab to facilitate the training of KM-52a mice. Each mouse will sit in front of a computer practicing logic exercises. It will be presented with several propositional logic statements in **Horn clauses**. It will read them and then type in a logical query, which the statements should be able to prove. Your job is to write a program that will check each conclusion a mouse makes and give it immediate feedback as to whether the query can be proven. Thus, the mice will learn very quickly via feedback a strong understanding of logic.

To help you develop your system, Dr. Beakerman has provided you with several sample knowledge bases the mice have produced. The knowledge bases contain Horn clauses with the following defined operators:

Definition	Symbol
`NOT X`	`~X`
`X AND Y`	`X && Y`
`X IMPLIES Y`	`X => Y`

You will use **backward-chaining** to solve this problem (see Section 7.5 and 9.4 in AIMA 3d edition).

Input/Output: Your program will be given text files that contain samples from several mice. Each line contains a Horn clause that has the form:

$$A \wedge B \wedge C \wedge D \Rightarrow E$$

or a single positive or negative symbol. Note that none of the symbols in the implication clauses in Horn clauses are allowed to have a NOT symbol attached to it. For instance,

the above is a Horn clause, but $A \wedge \neg B \Rightarrow E$ is not. Disjunction (OR) is not allowed in Horn clauses.

Your program should bring in a text file called **kb.txt** from the same directory as your compiled program, and then request a query from the user. You should output **YES** if you can prove the query, otherwise **NO** (with no meaning that you either disapprove the query, or the knowledge base is incomplete to determine the query).

Example sample input file:

```
Made_Of_Wood => A_Witch
Weighs_Same_As_Duck && Floats_On_Water => Made_Of_Wood
Turned_Me_Into_A_Newt && Weighs_Same_As_Duck => Floats_On_Water
Has_A_Wart && Made_Of_Wood => Weighs_Same_As_Duck
Has_A_Wart && Turned_Me_Into_A_Newt => Weighs_Same_As_Duck
Has_A_Wart
Turned_Me_Into_A_Newt
```

Example run with the above input file:

```
Please enter your query: A_Witch
YES
```

I will provide some example input files (note that you'll need to rename them) that provide the KB, but not a query. You should figure out valid and invalid queries by hand in order to test your program and the KB.

Goal: TRAIN THE MICE!!!!!

TASK 2 (25%): Create a KB for the classic Wumpus World on a 4x4 grid. You should provide this as a text file sent along with your code. This KB should work with your program and should be in Horn form as noted above. You should pick the locations for 5 pits, the Wumpus and the gold. Be sure to craft symbols that represent useful queries for WW.

You are required to work in teams of 2 for this project. Team requests are due by 5pm, Monday, April 4th and you may not work with your partners from project 1, 2 or 3. If you do not have a team request in at this point, you will be assigned a random partner.

Deliverables: Your source code and KB.

DUE: April 15th at 11:59pm in the Digital Dropbox

Credit: T. N. Mundhenk and L. Itti, University of Southern California