

## Rule-Based Systems

Consider a system with the following rules.

Index	Antecedents	Consequents
R1	X employs rhythmic language	X is a poem
R2	X contains lines with a clear pattern	X is a poem
R3	X employs rhythmic language X is usually short X often depicts a folklore	X is a poem
R4	X is a poem X is popular from the late Middle Ages on	X is a sonnet
R5	X is a poem X originates from Sicily X often expresses romantic love	X is a sonnet
R6	X is a poem X originates from Sicily X contains 14 lines	X is a sonnet
R7	X is written by William Shakespeare X is a typical English sonnet	X is one of the best-known among the author's works
R8	X is printed on a paper with doodles X is printed on a paper with tea stains	X is printed on a tattered paper
R9	X is a sonnet X is one of the best-known among the author's works X is a must-read for high school students X is printed on a tattered paper	X is <i>Sonnet 18</i>

Suppose the working memory contains the following assertions:

- B often depicts a folklore
- B is usually short
- B employs rhythmic language
- B originates from Sicily
- B often expresses romantic love
- B is written by William Shakespeare
- B is a typical English sonnet
- B is a must-read for high school students
- B is printed on a tattered paper

The expert system resolves any conflict by the ordering. In other words,

1. when examining rules, the system always go from R1 to R9 sequentially; and
2. when examining antecedents in any rule, the system always follow the order as appeared in the table.

Questions:

1. **(Forward chaining)** Simulate how the expert system interprets the working memory in forward chaining by making a table with the relevant rule indices (e.g., R4) and by indicating any new assertions added to the working memory. An example of your answer is given as follows.

Step	Rules ready to be instantiated	Rule selected	New assertion
1	R1, R3, R7	R1	B is a poem
2	...	...	...

2. **(Backward chaining)** The expert system uses backward chaining and starts with the hypothesis “book B is *Sonnet 18*”. The system asks the user questions to build the working memory and instantiate rules. The user answers “yes” to any question corresponding to an assertion on the list given in the initial working memory and “no” otherwise. In addition, the system can read a previously stored answer to a repeated question, so it never asks the same question twice.
  - (a) If the system follows in a depth-first way, list the questions in the order it asks. Note: there should be 12 questions in total.
  - (b) If the system follows in a breadth-first way, list the questions in the order it asks. Note: there should be 13 questions in total.

Please be careful as an error in the middle of your answer means the portion after that is also incorrect.

3. **(Backward chaining)** Which of the two backward chaining versions of the expert system would be preferred? Choose one that supports your view.
  - (a) Depth-first, because questions tend to stay relevant to particular subproblems, rather than jumping around.
  - (b) Depth-first, because the answer will be produced more reliably.
  - (c) Breadth-first, because answers will be produced faster.
  - (d) Breadth-first, because questions tend to stay relevant to particular subproblems, rather than jumping around.