IAI - Exercise Sheet 7

This week we have a series of questions on Production Systems: two questions taken from past exam papers, followed by two questions that are more open ended.

Question 1 (Exam style question)

Consider the following system of rules and facts, where the variable x stands for a patient, "red_spots(x)" stands for "patient x has red spots", and so forth.

Rules:

R1:
IF:	fever(x) &
	red_spots(x)
THEN:	measles(x)

R5:
| IF: | measles(x) |
| THEN: | contagious(x) |

R2:
| IF: | runny_nose(x) |
| THEN: | cold(x) |

R6:
| IF: | meningitis(x) |
| THEN: | contagious(x) |

R3:
| IF: | cold(x) |
| THEN: | contagious(x) |

R7:
IF:	contagious(x) &
	dangerous(x)
THEN:	isolated(x)

R4:
IF:	fever(x) &
	stiff_neck(x)
THEN:	meningitis(x)

R8:
| IF: | meningitis(x) |
| THEN: | dangerous(x) |

Initial facts:

runny_nose(mary)   stiff_neck(john)   fever(john)

red_spots(mary)   fever(mary)

(a)   What are the basic components of a Production System? Describe what is meant by a "Recognize-Act Cycle" and why it is relevant to production systems.

(b)   What do "matching" and "binding" mean in this context? Give examples from the above system.

(c)   How is the "conflict set" defined in general, and what is the initial conflict set in the above system? How would you resolve the conflict in this case? Give reasons for your answer.

(d)   What can be derived from this knowledge base by forward reasoning? Explain your answer in detail.

(e)   How can isolated(john) be derived by backward reasoning?

(f)   Under which conditions would a mixture of forward and backward reasoning be advisable?

Question 2 (Exam style question)

(a)   Outline the principal components of a Production System.

(b)   In this context, explain the importance of "binding", "matching" and "conflict resolution".

(c)   Suppose you have a production system with the three rules:

> R1:   IF A , THEN E
>
> R2:   IF B AND F , THEN G
>
> R3:   IF C AND E , THEN F

and you have four initial facts: A, B, C, D.

Explain what is meant by "backward chaining" and show explicitly how it can be used to determine the truth, or otherwise, of fact G.

Explain what is meant by "forward chaining", and show explicitly how it can be used in this case to determine new facts.

Question 3

Most useful production system databases will contain a large amount of information that is irrelevant to the given problem being worked on, and this can make their use rather inefficient. Three traditional solutions to this problem are:

1.   Use backward chaining rather than forward chaining.

2.   Restrict forward chaining to a selected sub-set of rules.

3.   Rewrite the rule set using information from the goal, so that only relevant variable bindings (those belonging to a *magic set*) are considered during forward inference.

Explain how each of these approaches work, and suggest circumstances under which each one would be preferable to the others.   [Hint: See Russell & Norvig, Section 9.3]

Question 4

The system described in Question 1 might be regarded as the basis of a very simple medical diagnosis system. What other features could be added to that system in order to make it more useful?