

Questions 3: Logic and Rule-Based Reasoning

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Question 1

Use the equivalence of Boolean operations and set-theoretic operations to prove the duality (De Morgan's) laws:

$$\neg(a \wedge b) = \neg a \vee \neg b, \quad \neg(a \vee b) = \neg a \wedge \neg b$$

Hint: you can use Venn diagrams.

Question 2

Boolean variables take values in set $\{0, 1\}$, and elements 0 and 1 satisfy the law of contradiction

$$a \wedge \neg a = 0$$

and the law of excluded middle

$$a \vee \neg a = 1$$

Consider three sets $\emptyset \subset A \subset U$, where \emptyset is the empty and U is the universal set. Which of these sets correspond to 0 and 1 in Boolean logic? Use set-theoretic operations and the above laws to justify your answer.

Question 3

Consider the following production rule:

IF *green* THEN *walk*

- What is the antecedent of this rule?
- What is the consequent of this rule?
- Which part of the rule will be matched against the working during the recognise-act cycle?

Question 4

The following is the rule set of a simple weather forecast expert system:

1		IF	<i>cyclone</i>		THEN	<i>clouds</i>
2		IF	<i>anticyclone</i>		THEN	<i>clear sky</i>
3		IF	<i>pressure is low</i>		THEN	<i>cyclone</i>
4		IF	<i>pressure is high</i>		THEN	<i>anticyclone</i>
5		IF	<i>arrow is down</i>		THEN	<i>pressure is low</i>
6		IF	<i>arrow is up</i>		THEN	<i>pressure is high</i>

- a) Apply these rules if the working memory contains the fact: *arrow is down*. Show your answer in a table listing the rules matching the working memory (conflict set), which rule you apply, and changes to the working memory contents:

Cycle	Working Memory	Conflict set	Rule fired
⋮	⋮	⋮	⋮

- b) Suppose that the user interface of our ES allows the system to ask a user about the facts whether they are true or false. What question (or questions) the system should ask the user in order to conclude that the sky is clear? What will the user answer? Which rule will require the clarification from the user?