

CSE 460 2. Midterm

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I. QUESTION (16 POINTS)

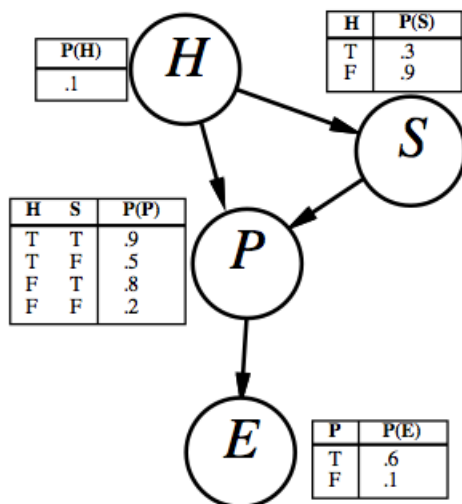
- (5 points) Draw a suitable network topology for the following set of two-valued nodes **FrozenBattery**, **IcyWeather**, **CarWontStart**, **NoGas**.
- (2 points) Give reasonable conditional probability tables associated with the **FrozenBattery** and **CarWontStart** nodes in your network.
- (3 points) How many independent values are contained in the joint probability distribution for four two-valued nodes assuming no conditional independence relations are known to hold among them.
- (3 points) How many independent probability values do your network tables contain include priors as appropriate?
- (3 points) Suppose we add another node for a broken starter motor called **BrokenSM**. Where would it go? Say briefly how your existing table for **CarWontStart** should be changed?

II. QUESTION (16 POINTS)

From “Horses are animals” it follows that “The head of a horse is the head of an animal”. Demonstrate that this inference is valid by carrying out the following steps:

- (6 points) Translate the premise and the conclusion into the language of first order logic. Use three predicates:
 - Head-of(x, y): x is the head of y.
 - Horse(x): x is a horse.
 - Animal(x): x is an animal.
- (4 points) Negate the conclusion, and convert the premise and the negated conclusion into conjunctive normal form.
- (6 points) Use resolution to show that the conclusion follows from the premise.

III. QUESTION (16 POINTS)



- (6 points) Which, if any of the following are asserted by the network structure?
 - $P(H, S) = P(H)P(S)$
 - $P(E|P, H) = P(E|P)$
 - $P(E) \neq P(E|H)$
- (4 points) Calculate the value of $P(h, s, \neg p, \neg e)$.
- (6 points) Calculate the probability that someone is elected given that they are honest.

IV. QUESTION (12 POINTS)

Represent the following sentences in predicate calculus.

- (3 points) All PCs are computers.
- (3 points) If someone owns a PC then there is some computer that they own.
- (3 points) MaryBeth owns a PC.
- (3 points) Anyone who owns a computer is a dweeb.

V. QUESTION (20 POINTS)

- (5 points) Does IV(a) logically entail IV(b)?
- (5 points) Does IV(b) logically entail IV(a)?
- (3 points) Apply existential elimination to IV(c).
- (7 points) Show exactly how backward chaining solves MaryBeth is a dweeb.

VI. QUESTION (20 POINTS)

- (2 points) Given the interpretation $P = \text{true}$, $Q = \text{false}$, determine the truth value of the following

$$[(P \wedge Q) \Rightarrow Q] \Leftrightarrow [P \vee \neg Q]$$

- (5 points) A propositional 2-CNF expression is a conjunction of clauses, each containing exactly 2 literals.

$$(A \vee B) \wedge (\neg A \vee C) \wedge (\neg B \vee D) \wedge (\neg C \vee G) \wedge (\neg D \vee G)$$

Prove using resolution that the above sentence entails G.

- (4 points) Is the following WFF valid? Justify your answer using a truth table.

$$[(P \vee Q) \wedge (Q \vee R)] \Rightarrow (P \vee R)$$

- (9 points) Formally show that S follows from the givens below.

$$\begin{aligned}
 &P \wedge Z \\
 &(\neg R \wedge \neg W) \vee (\neg P) \\
 &(W \wedge Q) \Rightarrow P \\
 &Q \vee W \\
 &Q \rightarrow (S \wedge P) \\
 &(P \vee Q) \rightarrow (S \wedge R)
 \end{aligned}$$