HW2

ⓘ This is a preview of the published version of the quiz

Started: Jul 25 at 10:02am

Quiz Instructions

Question 1

0 pts

Honor Pledge: Please type your name as a signature in the form.

> ***I avow that I will not give or receive any unauthorized help on this exam, and that all work will be my own.***

Question 2

1 pts

Write down the truth table for these sentences:

1. $(B \Rightarrow \neg A) \Rightarrow (B \wedge A)$
2. $(B \wedge \neg A) \wedge (\neg A \Rightarrow B) \wedge \neg(B \vee A)$

Question 3

2 pts

KB includes these rules:

- $(B \land D) \Rightarrow A$
- $(C \land E) \Rightarrow D$
- $C \land \neg F$

- $E \vee F$
- B

The query is A. Use Resolution Algorithm to infer this query from KB. You need to show the main two steps:

1. converting to CNF form;
2. applying the resolution inference rule.

Question 4

1 pts

Provide proofs for the following statements

1. The full resolution inference rule (on Slide 37) holds for any k, $n \geq 1$. During the lecture, we show the proof for the unit resolution inference rule. You can use a similar approach.
2. Horn clauses are closed under resolution: if you resolve two Horn clauses, you get back a Horn clause.

Question 5

2 pts

KB includes these rules:

- $(F \wedge D) \Rightarrow B$
- $(M \wedge G) \Rightarrow A$
- $A \Rightarrow B$
- $H \Rightarrow G$
- $E \Rightarrow B$
- $M \Rightarrow F$
- $C \Rightarrow H$
- $A \Rightarrow D$
- C
- M

The query is B. Use Forward Chaining with Table to infer this query from KB.

Question 6

1 pts

Consider the following Bayesian network, where F = having the u (f or ¬f) and C = coughing (c or ¬c).

F ⟶ C

We assume that P(f) = 0.8 and P(c|f) = 0.7 and P(c|¬f) = 0.2. Use Bayesian exact inference to obtain the following conditional probabilities:

1. P(¬f|c)
2. P(¬f|¬c)

Question 7

1 pts

Allergy could be another cause of coughing as shown in the following network, where A = having the allergy (a or ¬a).

$$\begin{tikzcd} F \arrow[dr] & & A \arrow[dl] \\ & C & \end{tikzcd}$$

So we assume $P(f) = 0.8$, $P(a) = 0.3$, $P(c|f,a) = 0.75$, $P(c|\neg f,a) = 0.8$, $P(c|f,\neg a) = 0.95$, and $P(c|\neg f,\neg a) = 0.1$. Use Bayesian exact inference to obtain the following conditional probabilities:

1. $P(a|\neg c)$
2. $P(a|c,\neg f)$

Question 8

1 pts

Consider the same assumption in previous question. In addition, we consider a possible vomiting out of coughing as shown in the following network, where V = vomiting (v or ¬v).

$$
\begin{array}{ccc}
\mathbf{F} & & \mathbf{A} \\
 & \searrow \ \swarrow & \\
 & \mathbf{C} & \\
 & \downarrow & \\
 & \mathbf{V} &
\end{array}
$$

We assume that P(v|c) = 0.1 and P(v|¬c) = 0.2. Use Bayesian exact inference to obtain the value of P(f|¬v).

Question 9

1 pts

Consider the Bayesian network depicted in previous question. Are the following statements true? Justify your answers.

1. $F \perp A \mid V$
2. $F \perp V \mid A$

Question 10

1 pts

Consider the HMM depicted in the following network.

$$\begin{tikzcd} \mathbf{S_1} \arrow[r] \arrow[d] & \mathbf{S_2} \arrow[r] \arrow[d] & \mathbf{S_3} \arrow[r] \arrow[d] & \mathbf{S_4} \arrow[d] \\ \mathbf{Z_1} & \mathbf{Z_2} & \mathbf{Z_3} & \mathbf{Z_4} \end{tikzcd}$$

Are the following statements true? Justify your conclusions.

1. $Z_1 \perp Z_3 \mid S_1$
2. $Z_2 \perp S_4 \mid S_1$
3. $S_1 \perp S_4 \mid S_2$
4. $Z_1 \perp S_4 \mid S_2$

Question 11

1 pts

Consider the HMM depicted in previous question. How many probability parameters overall are required to represent the joint probability of all random variables with and without considering the Bayesian network for the following two cases, respectively?

1. All variables are binary
2. All variables are ternary

Question 12

2 pts

Consider the HMM depicted in previous question. Suppose that we have binary states (labeled s and ¬s) and binary observations (labeled o and ¬o) and the probabilities as in the following tables.

S_1	$P(S_1)$
s	0.75
¬s	0.25

S_i	S_{i+1}	$P(S_{i+1}\|S_i)$
s	s	0.9
s	¬s	0.1
¬s	s	0.2
¬s	¬s	0.8

S_i	Z_i	$P(Z_i\|S_i)$
s	o	0.7
s	¬o	0.3
¬s	o	0.4
¬s	¬o	0.6

We observe the following sequence: Z_1=o and Z_2=¬o. Use the forward algorithm to obtain the following probabilities given that $P(S_1=\neg s|Z_1=o)=0.16$:

1. $P(S_2=\neg s|Z_1=o)$
2. $P(S_2=\neg s|Z_1=o, Z_2=\neg o)$

Question 13

1 pts

Download particle filtering demo code in Python from this link: **https://github.com/mjl/particle_filter_demo** (https://github.com/mjl/particle_filter_demo) . Please run it and include in your report a screenshot after the center of cluster are very close to the robot. Then highlight the code segments which are corresponding to the three major steps at each update cycle. Also explain each step with your own sentences.

Question 14

1 pts

We use Gaussian distribution $N(\mu,\sigma^2)$ to track the location of an object in 1-dimensional space. We assume the prior position follows N(2,5). Then we have the following four sequential actions:

1. Motion following N(3,7);
2. Sensing following N(1,4).

What Gaussian distributions does the posterior position follow after each of the above actions, respectively?

Question 15

0 pts

If you prefer to submit all your image solutions as one file, you can submit it here. Please use word or pdf file format.

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