

**National University of Singapore  
School of Computing  
CS3243 Introduction to AI**

**Final Examination Revision**

Issued: April 8, 2022

Discussion in: Week 13

1. Ancient Lore in the World of Adventure tells us that:

- Every dragon sleeps in some lair.
- Every wyvern is a dragon, and every wyvern is poisonous.
- Every lair in which a poisonous dragon sleeps is toxic.
- Anything that sleeps in anything that is toxic has slime minions.

The above are to be taken as facts in the World of Adventure.

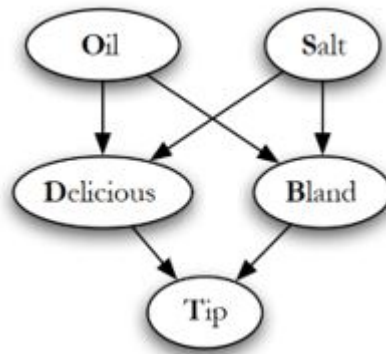
A wizard now claims that every wyvern has slime minions.

Using resolution, prove the wizard's claim. Note that you should NOT use first-order logic (FOL).

2. An ambitious restaurant waiter wants to maximise the number of tips he earns. He notices that whether patrons tip or not depends on the quality of the chef's cooking. When the chef uses more *Oil* and more *Salt*, more people comment that the food is *Delicious* and fewer people say that the food is *Bland*. When people comment that the food is *Delicious*, the waiter is much more likely to receive a *Tip*.

- (a) If the waiter models this by writing down the joint probability distribution table, what is the minimum number of table entries required to fully specify the scenario? Write the answer as a decimal number.

Suppose that the employee does not want to write down a table that large. Instead, he uses his domain knowledge to represent the scenario as the following Bayesian Network.



- (b) Recall that a Bayesian Network represents the full joint distribution in a compact form by exploiting knowledge of which variables are conditionally independent. Write down the formula that this Bayesian Network expresses for the joint probability distribution,  $Pr[O, S, B, D, T]$ .
- (c) Which of the following statements is true for the given Bayesian Network?
- Delicious* and *Bland* are conditionally independent causes for the effect, *Tip*.
  - Oil* and *Salt* are independent events.
  - Given the values of *Oil* and *Salt*, *Delicious* is conditionally independent of every other value.
  - Given the values of *Delicious* and *Bland*, *Tip* is conditionally independent of every other value.

(d) Suppose that we are given that  $Pr[O] = 0.4$ ,  $Pr[S] = 0.2$ , and the following.

$O$	$S$	$Pr[D O, S]$	$O$	$S$	$Pr[B O, S]$	$D$	$B$	$Pr[T D, B]$
$F$	$F$	0.2	$F$	$F$	0.7	$F$	$F$	0.2
$F$	$T$	0.4	$F$	$T$	0.4	$F$	$T$	0.1
$T$	$F$	0.3	$T$	$F$	0.4	$T$	$F$	0.6
$T$	$T$	0.6	$T$	$T$	0.1	$T$	$T$	0.3

(Note: *Delicious* and *Bland* are not opposites of each other. Some people at the table might comment that the food is *Delicious*, whereas others might comment that it is *Bland*. The *Tip* probability is expressed in terms of whether at least one  $D/B$  comment was heard.)

Compute the following probabilities (give the answers as decimal values, e.g., 0.3; express your answer to 3 significant figures):

- Probability that a *Tip* was offered, given that someone said the food is *Bland*.
- Probability that someone said the food was *Delicious*.
- Probability that the chef added *Oil*, given that someone said the food was *Delicious*.