Template Models

Latest Submission Grade 90%

1. Markov Assumption. 1 / 1 point

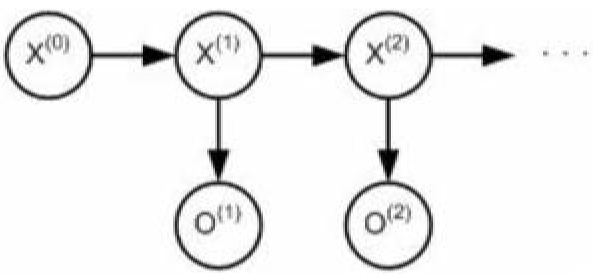
If a dynamic system X satisfies the Markov assumption for all time $t \geq 0$, which of the following statements must be true? You may select 1 or more options.

- [ ] $(X^{(t+1)} \perp X^{(0:(t-1))})$
- [ ] $P(X^{(t+1)}) = P(X^{(t-1)})$ for all possible values of X
- [x] $(X^{(t+1)} \perp X^{(0:(t-1))} | X^{(t)})$

Correct

2. Independencies in DBNs. 0 / 1 point

In the following DBN, which of the following independence assumptions are true? You may select 1 or more options.



- [x] $(O^{(t)} \perp O^{(t-1)} \mid X^{(t)})$

Correct
When $X^{(t)}$ is known, there is no active trail from $O^{(t)}$ to any other node in the network.

- [ ] $(O^{(t)} \perp X^{(t+1)} \mid X^{(t)})$
- [x] $(O^{(t)} \perp X^{(t-1)} \mid X^{(t)})$

Correct
When $X^{(t)}$ is known, there is no active trail from $O^{(t)}$ to any other node in the network.

- [x] $(O^{(t)} \perp O^{(t-1)})$

This should not be selected

3. **Applications of DBNs.**

1 / 1 point

For which of the following applications might one use a DBN (i.e. the Markov assumption is satisfied)? You may select 1 or more options.

- [ ] Modeling data taken at different locations along a road, where the data at each location is influenced by the data at many other locations.
- [ ] Predicting the probability that today will be a snow day (school will be closed because of the snow), when this probability depends only on whether yesterday, the day before yesterday, and 2 Mondays ago were snow days.
- [x] Modeling time-series data, where the events at each time-point are influenced by only the events at the one time-point directly before it

Correct
This perfectly satisfies the Markov assumption.

- [x] Predicting the probability that today will be a snow day (school will be closed because of the snow), when this probability depends only on whether yesterday was a snow day.

Correct
Let each day be a time slice, and order the days in chronological order. Viewed in this way, this data satisfies the Markov assumption.

4. **Plate Semantics.**

1 / 1 point

"Let A and B be random variables inside a common plate indexed by i. Which of the following statements must be true? You may select 1 or more options.

- [x] There is an instance of A and an instance of B for every i.

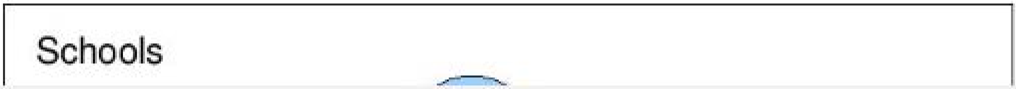
Correct

- [ ] For each i, A(i) and B(i) have different CPDs.
- [ ] For each i, A(i) and B(i) have the same CPDs.
- [ ] For each i, A(i) and B(i) are not independent.

5. ***Plate Interpretation.**

1 / 1 point

Consider the plate model below (with edges removed). Which of the following might a given instance of X possibly represent in the grounded model? (You may select 1 or more options. Keep in mind that this question addresses the variable's semantics, not its CPD.)



5. ***Plate Interpretation.**

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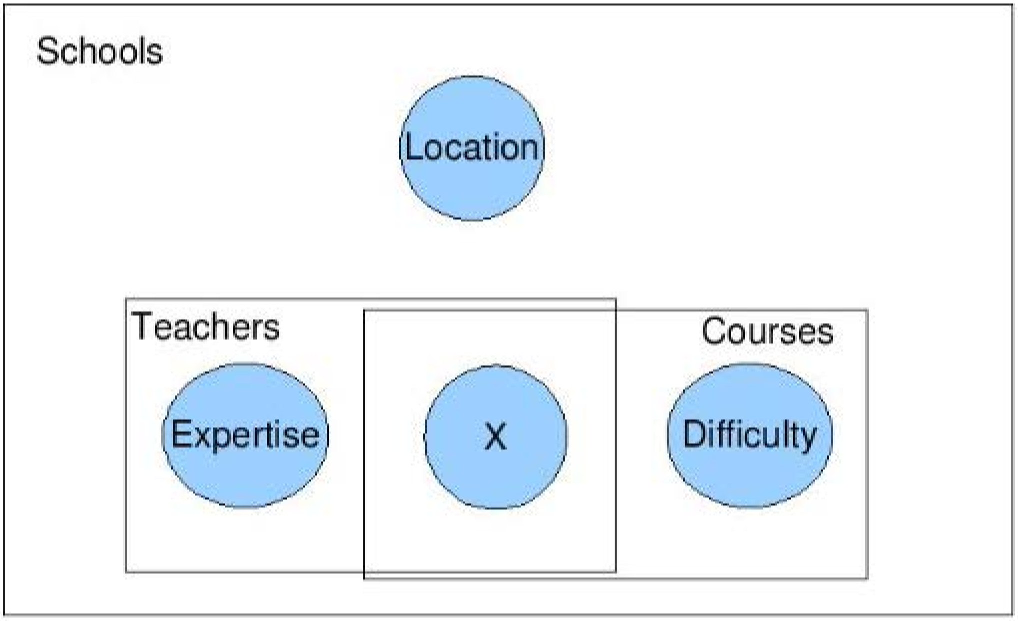


- [ ] Whether a teacher with expertise E taught a course of difficulty D
- [ ] None of these options can represent X in the grounded model
- [ ] Whether someone with expertise E taught something of difficulty D at school S
- [x] Whether a specific teacher T taught a specific course C at school S

Correct
In the grounded model, there will be an instance of X for each combination of Teacher, Course, and School. Thus, we are looking at a random variable that will say something about a specific teacher, class, and school combination. The correct answer is the only one that does this.

- [ ] Whether a specific teacher T is a tough grader

6. **Grounded Plates.**

1 / 1 point

Using the same plate model, now assume that there are s schools, t teachers in each school, and c courses taught by each teacher. How many instances of the Difficulty variable are there?

- ( ) stc
- ( ) c^s

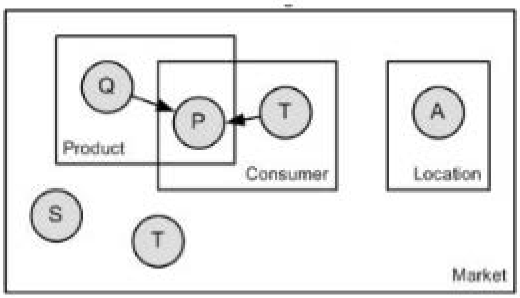
6. **Grounded Plates.** 1 / 1 point

Using the same plate model, now assume that there are s schools, t teachers in each school, and c courses taught by each teacher. How many instances of the Difficulty variable are there?

- ○ stc
- ○ c^s
- ○ st
- ◉ sc

Correct
There is a variable for every combination of school and course.

7. **Template Models.** Consider the plate model shown below. Assume we are given K Markets, L Products, M Consumers and N Locations. What is the total number of instances of the variable P in the grounded BN? 1 / 1 point



- ◉ $K \cdot L \cdot M$
- ○ $K \cdot L \cdot M \cdot N$
- ○ $(L \cdot M)^K$
- ○ $K \cdot (N + (L \cdot M))$

Correct
There will be one grounded instance of P for each combination of Market, Consumer, and Product. There will be $K \cdot L \cdot M$ of these combinations.

8. **Template Models.** Consider the plate model from the previous question. What might P represent? 1 / 1 point

- ◉ Whether a specific product PROD was consumed by consumer C in market M
- ○ Whether a specific product PROD was consumed by consumer C in all markets
- ○ Whether a specific product of brand q was consumed by a consumer with age t in a market of type m that is

8. Template Models. Consider the plate model from the previous question. What might P represent?

1 / 1 point

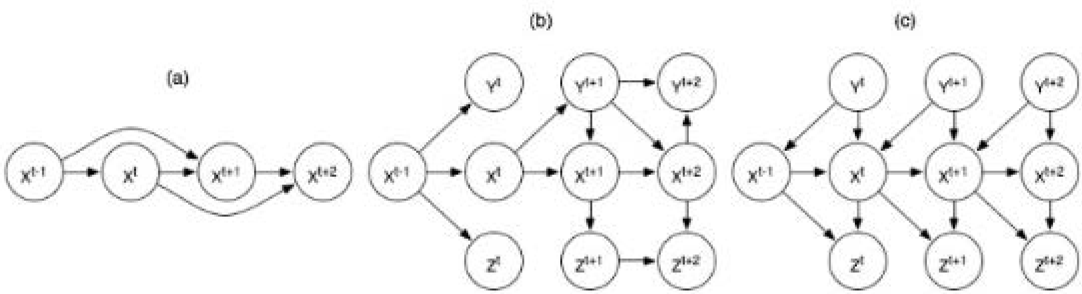
- (•) Whether a specific product PROD was consumed by consumer C in market M
- ( ) Whether a specific product PROD was consumed by consumer C in all markets
- ( ) Whether a specific product of brand q was consumed by a consumer with age t in a market of type m that is in location a
- ( ) Whether a specific product PROD was consumed by consumer C in market M in location L

Correct

In the grounded model, there will be an instance of P for each combination of Product and Consumer, and there is a combination like this for each Market. Thus, we are looking at a random variable that will say something about a specific product, market, and consumer combination. The correct answer is the only one that does this.

9. Time-Series Graphs. Which of the time-series graphs satisfies the Markov assumption? You may select 1 or more options.

1 / 1 point



- [ ] (a)
- [x] (b)

Correct

(b) is a time-series graph in which all variables in each time slice are independent of all variables in time slices at least 2 time slices before, given all variables in the previous time slice ($X^{(t+1)}, Y^{(t+1)}, Z^{(t+1)} \perp X^{(t-1)}, Y^{(t-1)}, Z^{(t-1)} | X^{(t)}, Y^{(t)}, Z^{(t)}$).

- [ ] (c)

10. *Unrolling DBNs. Below are 2-TBNs that could be unrolled into DBNs. Consider these unrolled DBNs (note that there are no edges within the first time-point). In which of them will $(X^{(t)} \perp Z^{(t)} \mid Y^{(t)})$ hold for all t, assuming $Obs^{(t)}$ is observed for all t and $X^{(t)}$ and $Z^{(t)}$ are never observed? You may select 1 or more options.

1 / 1 point

Hint: Unroll these 2-TBNs into DBNs that are at least 3 time steps long (i.e., involving variables from $t-1, t, t+$

☐ (a)

☑ (b)

Correct
(b) is a time-series graph in which all variables in each time slice are independent of all variables in time slices at least 2 time slices before, given all variables in the previous time slice ($X^{(t+1)}, Y^{(t+1)}, Z^{(t+1)} \perp X^{(t-1)}, Y^{(t-1)}, Z^{(t-1)} | X^{(t)}, Y^{(t)}, Z^{(t)}$).

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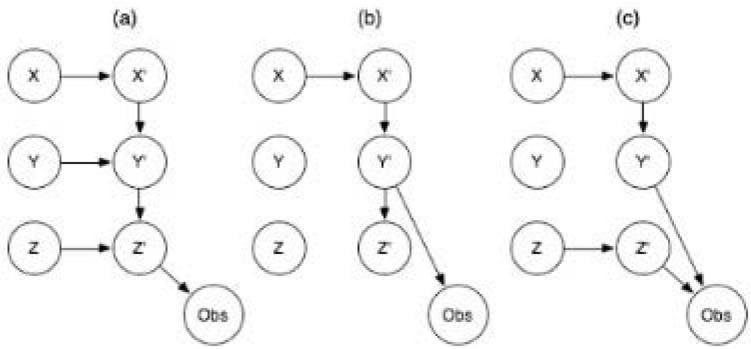
1 / 1 point

Hint: Unroll these 2-TBNs into DBNs that are at least 3 time steps long (i.e., involving variables from $t-1, t, t+1$).



☐ (a)

☑ (b)

Correct
The independence assumption holds in this network because knowing $Y^{(t)}$ blocks what was the only active trail from $X^{(t)}$ to $Z^{(t)}$.

☐ (c)