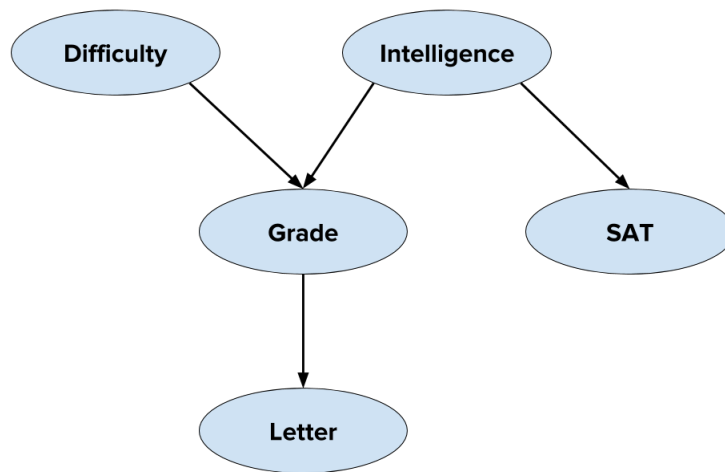


# Assignment 9

## Introduction to Machine Learning

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1. Here is a popular toy graphical model. It models the grades obtained by a student in a course and its implications. Difficulty represents the difficulty of the course and intelligence is an indicator of how intelligent the student is, SAT represents the SAT scores of the student and Letter presents the event of the student receiving a letter of recommendation from the faculty teaching the course.



Given this graphical model, which of the following statements are true? Note - More than one can be correct.

- (a) Given the grade, difficulty and letter are independent variables.
  - (b) Given grade, difficulty and intelligence are independent
  - (c) Without knowing any information, Difficulty and Intelligence are independent.
  - (d) Given the intelligence, SAT and grades are independent.
2. The random variables given in the previous model are modeled as discrete variables and the corresponding CPDs are as below.

$d^0$	$d^1$
0.6	0.4

$i^0$	$i^1$
0.7	0.3

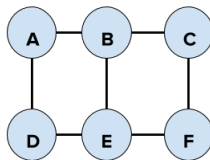
	$g^1$	$g^2$	$g^3$
$i^0, d^0$	0.3	0.4	0.3
$i^0, d^1$	0.05	0.25	0.7
$i^1, d^0$	0.9	0.08	0.02
$i^1, d^1$	0.5	0.3	0.2

	$s^0$	$s^1$
$i^0$	0.95	0.05
$i^1$	0.2	0.8

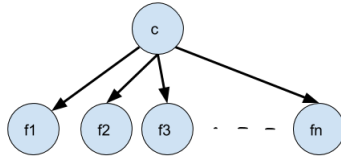
	$l^0$	$l^1$
$g^1$	0.1	0.9
$g^2$	0.4	0.6
$g^3$	0.99	0.01

What is the probability of  $i^1, d^0, g^2, s^1, l^0$  occurring?

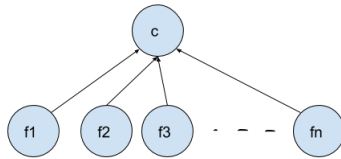
- (a) 0.004608
  - (b) 0.003872
  - (c) 0.001
  - (d) 0.0078
3. Using the given example and CPD's compute the probability of following assignment,  $i^1, g^1, s^1, l^1$  irrespective of the difficulty of the course?
- (a) 0.16
  - (b) 0.2
  - (c) 0.5
  - (d) 0.6
4. Which of the following is a valid Gibbs distribution over this graph?



- (a)  $\frac{\phi(A)\phi(B)\phi(C)\phi(D)\phi(E)\phi(F)}{Z}$ , where Z is the partition function.
  - (b)  $\frac{\phi(A,B,D)\phi(C,E,F)}{Z}$ , where Z is the partition function
  - (c) There is no Gibbs distribution for this Markov network
  - (d)  $\phi(A)\phi(B)\phi(C)\phi(D)\phi(E)\phi(F)$
5. Which of the following graphical models capture the Naive Bayes assumption, where c represents the class label and fi are the features?



(a)

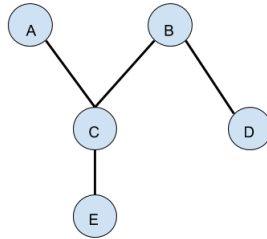


(b)

(c) It cannot be captured by a graphical model.

(d) Graphical model can capture the assumption, but the given models don't do it.

6. Consider the following graphical model and identify which of the pairs of random variables are independent?



(a) A, B

(b) C, D

(c) E, D

(d) None of them.

7. What is the value obtained on marginalizing all the variables in a graphical model?

(a) Depends on the model

(b) Some value less than 1

(c) 1

(d) Some value greater than 1