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First Semester Class Test 2018/19 (2)

Advanced Artificial Intelligence

TIME ALLOWED : 50 minutes

INSTRUCTIONS TO CANDIDATES

Answer FOUR questions.

If you attempt to answer more questions than the required number of questions (in any section), the marks awarded for the excess questions answered will be discarded (starting with your lowest mark).

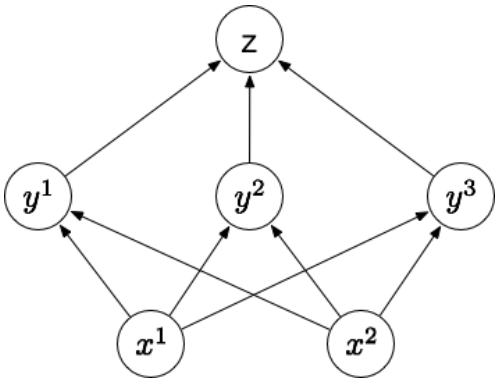

Figure 1: A simple 3-layer neural network

input

4	5	2	1	7
4	6	1	9	1
4	6	7	2	2
5	6	9	2	2
3	5	9	8	7

filter

2	3
3	2

Figure 2: A two-dimensional input and a convolutional filter

Part 3: Deep Learning

1. Figure 1 gives a simple 3-layer neural network with 2 inputs x^1, x^2 and a single output z. Please indicate which of the following expression is correct for the gradient $\frac{\partial z}{\partial x^2}$?

0 $\frac{\partial z}{\partial y^1}\frac{\partial y^1}{\partial x^2}$

0 $\frac{\partial z}{\partial y^2}\frac{\partial y^2}{\partial x^2}$

0 $\frac{\partial z}{\partial y^1}\frac{\partial y^1}{\partial x^2} + \frac{\partial z}{\partial y^2}\frac{\partial y^2}{\partial x^2} + \frac{\partial z}{\partial y^3}\frac{\partial y^3}{\partial x^2}$

0 $\frac{\partial z}{\partial y^1}\frac{\partial y^1}{\partial x^2}\frac{\partial z}{\partial y^2}\frac{\partial y^2}{\partial x^2}\frac{\partial z}{\partial y^3}\frac{\partial y^3}{\partial x^2}$

2. The following four questions are related to Figure 2. In Figure 2, we have a two-dimensional input and a convolutional filter. Please indicate which of the following statement is correct if zero-padding is not applied ?

0 the result is a one dimensional array of length 16

0 the result is a one dimensional array of length 25

0 the result is a two dimensional array of shape $(4, 4)$

0 the result is a two dimensional array of shape $(5, 5)$

3. Continue with the above question. Please indicate which of the following statements are correct for the result of applying the convolutional filter on the input ?

0 there is an element 47

0 there is an element 39

0 there is an element 34

0 there is an element 48

4. Take the same input as in Figure 2 and apply maxpooling on 2×2 filter. Assume that we ignore those entries on which no pooling operations are applied. Please indicate which of the following statement is correct ?

- **0** the result is a one dimensional array of length 2
- **0** the result is a one dimensional array of length 4
- **0** the result is a two dimensional array of shape $(2, 2)$
- **0** the result is a two dimensional array of shape $(4, 4)$

5. Continue with the above question. Please indicate which of the following statements are correct for the result of applying maxpooing on 2×2 filter on the input ?

- **0** there is a single element with value 6
- **0** there is a single element with value 9
- **0** there are two elements with value 6
- **0** there are two elements with value 9

6. Which of the following statements are correct with respect to the features and feature manifolds ?

- **0** In an end-to-end learning of feature hierarchy, initial modules capture low-level features, middle modules capture mid-level features, and last modules capture high level, class specific features.
- **0** It is very often that high-dimensional data lie in lower dimensional feature manifolds.
- **0** Feature manifolds are linear, so it is easier to compute.
- **0** The computation of the coordinates of the data with respect to feature manifolds enables an easy separation of the data.

Part 4: Probabilistic Graphical Models

10. Please select two structures which are key for Bayesian Networks to represent joint probability distribution:

- **0** chain rules
- **0** joint probability distribution table
- **0** graph
- **0** conditional probability distributions

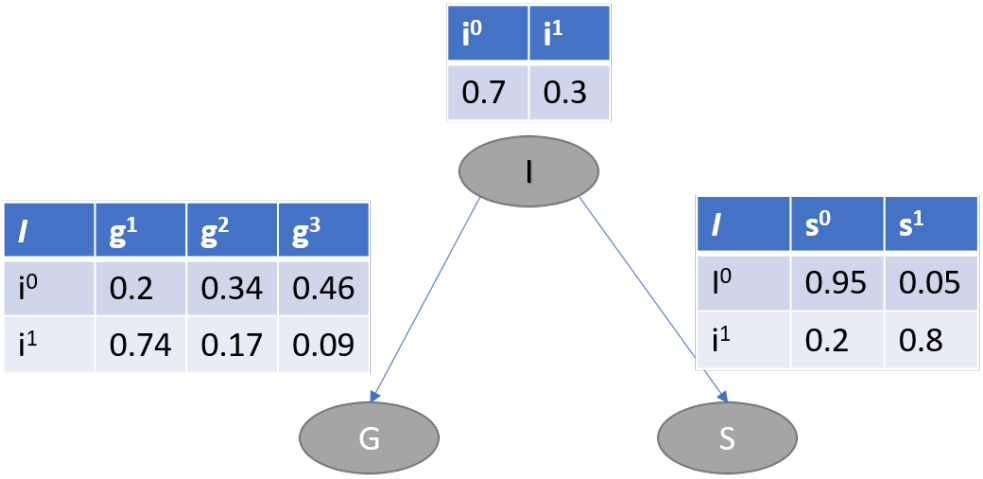

Figure 3: Simple Probabilistic Graphical Model

X	Y	P(X,Y)
x^0	y^0	0.08
x^0	y^1	0.32
x^1	y^0	0.12
x^1	y^1	0.48

(a)

X	Y	P(X,Y)
x^0	y^0	0.10
x^0	y^1	0.16
x^1	y^0	0.64
x^1	y^1	0.10

(b)

Figure 4: Joint probability of two random variables

11. Figure 3 provides a simple probabilistic graphical model of three variables S, G, and I. We already know that

$$P \models (S \perp G \mid I)$$

Which of the following is the value of $P(i^1, s^1, g^2)$?

0 0.0409

0 0.0408

0 0.235

0 0.480

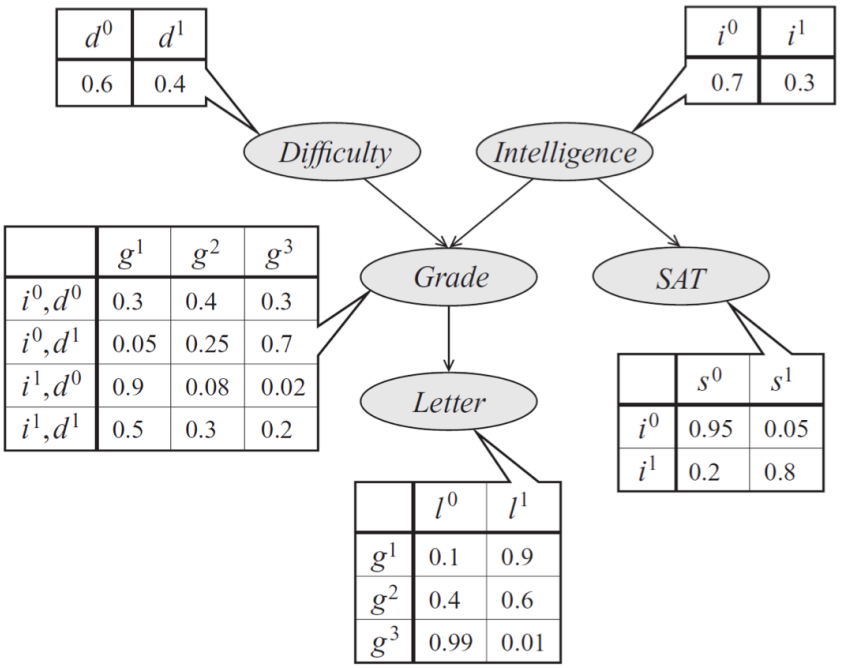

Figure 5: A Bayesian network

12. Figure 4 (a) provides a joint probability P. Let $I(P)$ to be the set of conditional independence assertions of the form $(X \perp Y | Z)$ that hold in P. Which of the following is correct?

- **0** $(X \perp \emptyset \mid Y) \in I(P)$
- **0** $(X \perp Y \mid \emptyset) \in I(P)$
- **0** $(Y \perp \emptyset \mid X) \in I(P)$
- **0** $I(P) = \emptyset$

13. Figure 4 (b) provides a joint probability P. Let $I(P)$ to be the set of conditional independence assertions of the form $(X \perp Y | Z)$ that hold in P. Which of the following is correct?

- **0** $(X \perp \emptyset \mid Y) \in I(P)$
- **0** $(Y \perp \emptyset \mid X) \in I(P)$
- **0** $(X \perp Y \mid \emptyset) \in I(P)$
- **0** $I(P) = \emptyset$

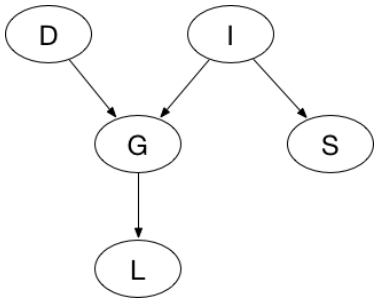

Figure 6: A simple probabilistic graphical model

14. Consider the Bayesian network model G in Figure 5 and indicate which of the following are in $I(G)$:

- **0** $(L \perp I, D, S \mid G)$
- **0** $(G \perp S \mid D, I)$
- **0** $(I \perp D \mid \emptyset)$
- **0** $(D \perp I, S \mid \emptyset)$

15. Consider the Bayesian network model G in Figure 5 and calculate the following value

$$P(i^1, d^0, g^2, s^1, l^0) =$$

- **0** 0.4608
- **0** 0.004608
- **0** 0.5329
- **0** 0.001435

16. Consider the probabilistic graphical model in Figure 5 and indicate which of the following statements are correct.

- **0** We can do evidential reasoning by computing $P(l^1)$ and $P(l^1 \mid i^0, d^0)$
- **0** We can do causal reasoning by computing $P(i^1)$ and $P(i^1 \mid l^0, g^0)$
- **0** We can do intercausal reasoning by computing $P(i^1)$ and $P(i^1 \mid l^0, g^0)$
- **0** We can do causal reasoning by computing $P(l^1)$ and $P(l^1 \mid d^0)$

17. Consider the probabilistic graphical model in Figure 6 and indicate which of the following statements are correct.

- **0** D can influence I when G is not observed and L is observed
- **0** D can influence L when G is observed
- **0** G can influence S when I is not observed
- **0** D can influence I when G is observed

18. Consider the probabilistic graphical model in Figure 6 and indicate which of the following statements about the observations can enable the influence of D over S.

- **0** G and L are observed, I is not observed
- **0** G is observed, L and I are not observed
- **0** G and I are observed, L is not observed
- **0** L is observed, G and I are not observed