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# CS264A: Automated Reasoning

Fall 2020

Homework 4

Due Date: Sunday, December 13

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1. (25pt) Consider a linear classifier  $f(X, Y, Z) = -6 \cdot X + 5 \cdot Y - 4 \cdot Z + 3$ , where  $X, Y, Z$  are binary features (each takes values in  $\{0, 1\}$ ). The classifier labels an instance positively iff  $f(X, Y, Z) \geq 0$ . For example, since  $f(1, 1, 1) = -2 < 0$ , the instance  $X = 1, Y = 1, Z = 1$  is labeled negatively.
- (a) (7pts) What is the classification function given  $X = 1, Y = 1$ ? In general, what is the form of the classification function after we know the values of features  $X, Y$ ?
- (b) (15pts) Draw a reduced OBDD representing the decision function of the classifier, using variable order  $X, Y, Z$ .
- (c) (3pts) If an instance has  $X = 1$  and  $Y = 0$ , will the value of feature  $Z$  affect the instance classification?

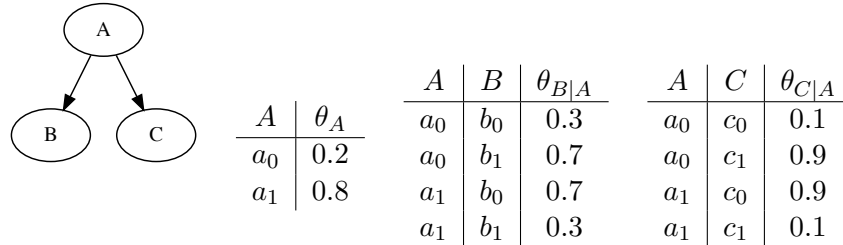


Figure 1: Bayesian network.

2. (25pt) Consider the Bayesian network in Figure 1 and suppose we want to compute the most probable explanation (MPE) for this network.
- (a) (15pt) Show the weighted CNF which can be used to compute MPE using weighted MaxSAT.
- (b) (3pt) Modify this weighted CNF so it can be used to compute MPE under evidence  $B = b_1$ .
- (c) (7pt) What is the MPE instantiation under  $B = b_1$ , what is the corresponding instantiation of indicator variables, and what is the weight and penalty of this indicator instantiation?
3. (25pt) Compute the prime implicants of the following DNF using the *consensus* method.

$$\bar{w}\bar{x}\bar{y}\bar{z} + \bar{w}\bar{x}\bar{y}z + \bar{w}x\bar{y}\bar{z} + w\bar{x}\bar{y}\bar{z} + w\bar{x}\bar{y}z + w\bar{x}yz + wxyz + wxyz.$$

4. (25pt) Consider the following classifier and suppose that  $R$  is a protected feature.

$$\Delta = [E \wedge [(F \wedge (G \vee W)) \vee (\neg F \wedge R)]] \vee [G \wedge R \wedge W].$$

- (a) (5pt) What is the decision (yes, no) on instance  $E, \neg F, G, W, R$ ?
- (b) (15pt) Which of the following are sufficient reasons (PI-explanations) for this decision?

$(E, G, R), (E, W), (E, G, R, \neg F), (E, G, W).$

- (c) (5pt) Is this decision biased? Why?