CS-171, Intro to A.I. — Quiz#4 — Fall Quarter, 2016 — 20 minutes

YOUR NAME: SOLUTIONS

YOUR ID: _____ ROW & SEAT: Lecture (1pt)

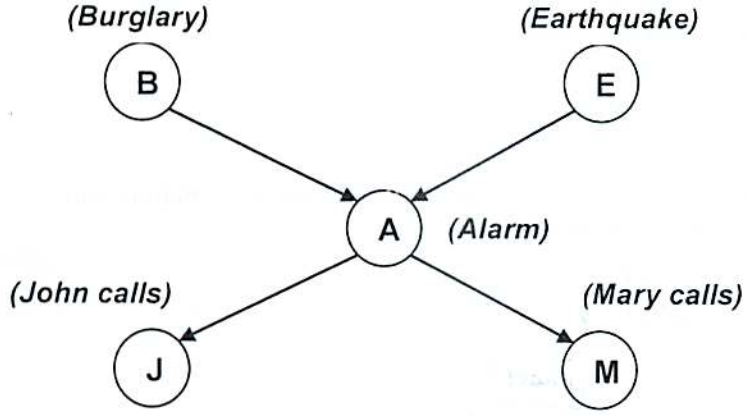
1. (10 pts) Definition of conditional probability. Write down the definition of P(H | D) in terms of P(H), P(D), P(H ∧ D), and P(H ∨ D).

P(H | D) = $P(H \wedge D) / P(D)$.

2. (10 pts) Bayes' Rule. Write down the result of applying Bayes' Rule to P(H | D), i.e., write down P(H | D) in terms of P(H), P(D), and P(D | H).

P(H | D) = $\frac{P(D \mid H) \cdot P(H)}{P(D)}$

3. (20 pts total, -5 for each error, but not negative) Bayesian Networks. Shown below is the Bayesian network corresponding to the Burglar Alarm problem, P(J | A) P(M | A) P(A | B, E) P(B) P(E).



P(B)
.001

P(E)
.002

B	E	P(A)
t	t	.95
t	f	.94
f	t	.29
f	f	.001

A	P(J)
t	.90
f	.05

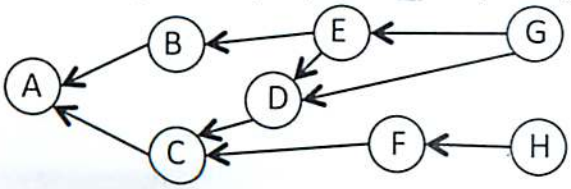
A	P(M)
t	.70
f	.01

Write down an expression that will evaluate to P(J=t ∧ M=f ∧ A=t ∧ B = f ∧ E = t). Express your answer as a series of numbers (numerical probabilities) separated by multiplication symbols. You do not need to carry out the multiplication to produce a single number (probability). **SHOW YOUR WORK.**

P(J=t ∧ M=f ∧ A=t ∧ B = f ∧ E = t) $= P(B=f) \cdot P(E=T) \cdot P(A=T \mid B=f, E=T) \cdot P(J=T \mid A=T) \cdot P(M=f \mid A=T)$

= $= (.999) \times (.002) \times (.29) \times (.90) \times (.30)$

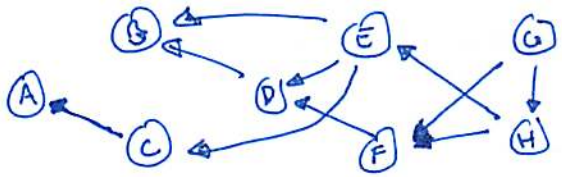
4. (15 pts total, -5 for each error, but not negative) Bayesian Networks. Write down the factored conditional probability expression corresponding to this Bayesian Network.



$P(G)\, P(H)\, P(F \mid H)\, P(E \mid G)\, P(D \mid E, G)$
$P(C \mid D, F)\, P(B \mid E)\, P(A \mid B, C)$.

5. (15 pts total, -5 for each error, but not negative) Bayesian Networks. Draw the Bayesian Network corresponding to this factored conditional probability expression. Draw left-to-right, as in Problem 4.

P(A | C) P(B | D, E) P(C | E) P(D | E, F) P(E | H) P(F | G, H) P(G) P(H | G)

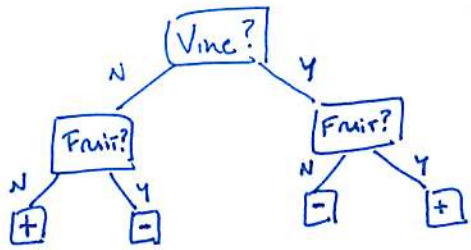


5. (29 pts total) Decision Tree Learning.

You are an agricultural robot given the following set of plant examples. Each is assigned a class label of + or — depending on whether or not it is a member of the target class:

Example	Vine?	Fruit?	Leaf?	Class
Watermelon	Yes	Yes	Curly	+
Ivy	Yes	No	Curly	—
Bougainvillea	Yes	No	Flat	—
Kudzu	Yes	No	Flat	—
Maple	No	No	Curly	+
Oak	No	No	Flat	+
Sycamore	No	No	Flat	+
Apple	No	Yes	Curly	—

5.a. (15 pts) Draw the decision tree that would be constructed by recursively applying information gain to select roots of sub-trees, as in the Decision-Tree-Learning algorithm.



5.b. (7 pts) What class is Grape? (Vine=Yes, Fruit=Yes, Leaf=Curly) +

5c. (7 pt) What class is Orange? (Vine=No, Fruit=Yes, Leaf=Curly) —