CS-171, Intro to A.I. — Quiz#4 — Fall Quarter, 2012 — 20 minutes

YOUR NAME: _____

YOUR ID: _____ ID TO RIGHT: _____ ROW: _____ NO. FROM RIGHT: _____

1. (5 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 ∧ D) / P(D)

2. (5 pts) Bayes' Rule. Write down the result of applying Bayes' Rule to P(H | D).

P(H | D) = P(D | H) P(H) / P(D)

3. (5 points) Logic and possible worlds. Write down an FOPC sentence such that every world in which it is true contains exactly one object.

∃x ∀y, x=y [(∀x ∀y, x=y) is also OK because all worlds must contain at least one object.]
[(∃! x, x=x) is also OK (iff there's an appropriate predicate after "∃! x,"); it's just syntactic sugar]

4. (20 pts total, 4 pts each) Machine Learning. Label the following statements T (true) or F (false).

4a. T A decision tree can learn and represent any Boolean function.

4b. F The information gain from an attribute A is how much classifier accuracy improves when attribute A is added to the example feature vectors in the training set.

4c. T Overfitting is a general phenomenon that occurs with all types of learners.

4d. F Cross-validation is a way to improve the accuracy of a learned hypothesis by reducing over-fitting using Ockham's razor.

4e. T An agent is learning if it improves its performance on future tasks after making observations about the world.

5. (20 pts total, 4 pts each) Unifiers and Unification. Write the most general unifier (or MGU) of the two terms given, or "None" if no unification is possible. Write your answer in the form of a substitution as given in your book, e.g., {x / John, y / Mary, z / Bill}. The first one is done for you as an example.

5a. UNIFY(Knows(John, x), Knows(John, Jane)) { x / Jane }

5b. UNIFY(Knows(y, x), Knows(John, Jane)) { x / Jane, y / John }

5c. UNIFY(Knows(John, x), Knows(y, Father (y))) { y / John, x / Father (John) }

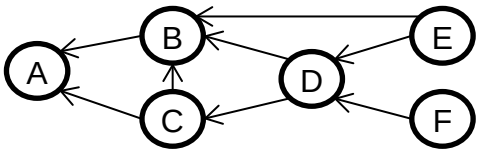
5d. UNIFY(Knows(John, F(x)), Knows(y, F(F(z)))) { y / John, x / F (z) }

5e. UNIFY(Knows(John, F(x)), Knows(y, G(z))) None

5f. UNIFY(Knows(John, F(x)), Knows(y, F(G(y)))) { y / John, x / G (John) }

****** TURN QUIZ OVER. QUIZ CONTINUES ON THE REVERSE. ******

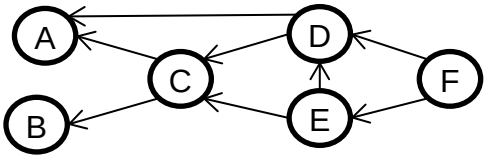
6. (15 pts total, -5 for each error, but not negative) Bayesian Networks. Write down the factored conditional probability expression corresponding to this Bayesian Network.



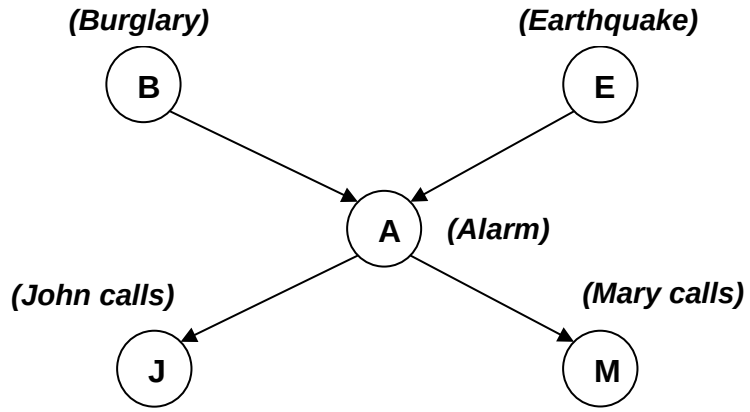
P(A | B, C) P(B | C, D, E) P(C | D) P(D | E, F) P(E) P(F)

7. (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 6.

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



8. (15 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=F $\wedge$ m=T $\wedge$ a=T $\wedge$ b = T $\wedge$ E = F). 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=F $\wedge$ m=T $\wedge$ a=T $\wedge$ b = T $\wedge$ E = F)

= P(j=F | a=T) * P(m=T | a = T) * P(a=T | b=T $\wedge$ e=F) * P(b=T) * P(E=F)

= .10 * .7 * .94 * .001 * .998