Below, for each problem on this test, “Perfect” is the percentage of students who received full credit, “Partial” is the percentage who received partial credit, and “Zero” is the percentage who received zero credit.

(Due to rounding, values below may be only approximate estimates.)

Problem 1.

Problem 2.

We will release these numbers as they become available.

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

YOUR NAME: ____

YOUR ID: ______________ ID TO RIGHT: See Section 8.1-4. ROW: __________ SEAT: __________

1. (70 pts total, 10 pts each) For each English sentence below, write the letter corresponding to its best or closest FOPC (FOL) sentence (wff, or well-formed formula). The first one is done for you, as an example.

1.a (example) __D__“Every butterfly likes some flower

A. $\forall x\ \forall y\ Butterfly(x) \wedge Flower(y) \wedge Likes(x, y)$

B. $\forall x\ \exists y\ Butterfly(x) \wedge Flower(y) \wedge Likes(x, y)$

C. $\forall x\ \forall y\ Butterfly(x) \Rightarrow (\ Flower(y) \wedge Likes(x, y)\ )$

D. $\forall x\ \exists y\ Butterfly(x) \Rightarrow (\ Flower(y) \wedge Likes(x, y)\ )$

1.b (10 pts) __B__ “All butterflies are insects.”

A. $\forall x\ Butterfly(x) \wedge Insect(x)$

B. $\forall x\ Butterfly(x) \Rightarrow Insect(x)$

C. $\exists x\ Butterfly(x) \wedge Insect(x)$

D. $\exists x\ Butterfly(x) \Rightarrow Insect(x)$

1.c (10 pts) __C__ “For every flower, there is a butterfly

A. $\forall x\ \exists y\ Flower(x) \wedge Butterfly(y) \wedge Likes(y, x)$

B. $\forall x\ \exists y\ [\ Flower(x) \wedge Butterfly(y)\ ] \Rightarrow Likes(y, x)$

C. $\forall x\ \exists y\ Flower(x) \Rightarrow [\ Butterfly(y) \wedge Likes(y, x)\ ]$

D. $\forall x\ \forall y\ Flower(x) \wedge Butterfly(y) \wedge Likes(y, x)$

1.d (10 pts) __A__ “Every butterfly likes every flower.”

A. $\forall x\ \forall y\ [\ Butterfly(x) \wedge Flower(y)\ ] \Rightarrow Likes(x, y)$

B. $\forall x\ \forall y\ Butterfly(x) \Rightarrow [\ Flower(y) \wedge Likes(x, y)\ ]$

C. $\forall x\ \forall y\ Butterfly(x) \wedge Flower(y) \wedge Likes(x, y)$

D. $\forall x\ \exists y\ [\ Butterfly(x) \wedge Flower(y)\ ] \Rightarrow Likes(x, y)$

1.e (10 pts) __B__ “There is some butterfly in Irvine tha

A. $\forall x\ Butterfly(x) \wedge In(x, Irvine) \wedge Pretty(x)$

B. $\exists x\ Butterfly(x) \wedge In(x, Irvine) \wedge Pretty(x)$

C. $\forall x\ [\ Butterfly(x) \wedge In(x, Irvine)\ ] \Rightarrow Pretty(x)$

D. $\exists x\ Butterfly(x) \Rightarrow [\ In(x, Irvine) \wedge Pretty(x)\ ]$

1.f (10 pts) __C__ “Every butterfly in Irvine is pretty.”

A. $\forall x\ Butterfly(x) \wedge In(x, Irvine) \wedge Pretty(x)$

B. $\exists x\ Butterfly(x) \wedge In(x, Irvine) \wedge Pretty(x)$

C. $\forall x\ [\ Butterfly(x) \wedge In(x, Irvine)\ ] \Rightarrow Pretty(x)$

D. $\exists x\ Butterfly(x) \Rightarrow [\ In(x, Irvine)\ ] \wedge Pretty(x)$

1.g (10 pts) __D__ “Every butterfly likes some flower.”

A. $\forall x\ \exists y\ [\ Butterfly(x) \wedge Flower(y)\ ] \Rightarrow Likes(x, y)$

B. $\forall x\ \exists y\ Butterfly(x) \wedge Flower(y) \wedge Likes(x, y)$

C. $\forall x\ \forall y\ Butterfly(x) \wedge Flower(y) \wedge Likes(x, y)$

D. $\forall x\ \exists y\ Butterfly(x) \Rightarrow [\ Flower(y) \wedge Likes(x, y)\ ]$

1.h (10 pts) __A__ “Some butterfly likes some flower.”

A. $\exists x\ \exists y\ Butterfly(x) \wedge Flower(y) \wedge Likes(x, y)$

B. $\exists x\ \exists y\ [\ Butterfly(x) \wedge Flower(y)\ ] \Rightarrow Likes(x, y)$

C. $\exists x\ \exists y\ Butterfly(x) \Rightarrow [\ Flower(y) \wedge Likes(x, y)\ ]$

D. $\forall x\ \forall y\ Butterfly(x) \wedge Flower(y) \wedge Likes(x, y)$

1.a **“Every butterfly likes some flower.”**
A. Everything(x,y) is a butterfly(x) and is a flower(y) and x likes y.
B, Everything(x) is a butterfly(x) and there is some flower(y) and x likes y.
C. If something(x) is a butterfly(x) then everything(y) is a flower(y) and x likes y.
D. Correct.

1.b **“All butterflies are insects.”**
A. Everything(x) is a butterfly(x) and is an insect(x).
B. Correct.
C. There is something(x) that is a butterfly(x) and is an insect(x).
D. Vacuously true if there is anything(x) that is not a butterfly(x).

1.c **“For every flower, there is a butterfly that likes that flower.”**
A. Everything(x) is a flower and there is some butterfly(y) and y likes x.
B. Vacuously true if there is anything(y) that is not a butterfly(y).
C. Correct.
D. Everything(x,y) is a flower(x) and is a butterfly(y) and y likes x.

1.d **“Every butterfly likes every flower.”**
A. Correct.
B. If anything(x) is a butterfly(x) then everything(y) is a flower(y) and x likes y.
C. Everything(x,y) is a butterfly(x) and is a flower(y) and x likes y.
D. Vacuously true if anything(y) is not a flower.

1.e. **“There is some butterfly in Irvine that is pretty.”**
A. Everything(x) is a butterfly and is in Irvine(x) and is pretty(x).
B. Correct.
C. If something(x) is a butterfly(x) and is in Irvine(x) then that thing is pretty(x).
D. Vacuously true if anything(x) is not a butterfly(x).

1.f **“Every butterfly in Irvine is pretty.”**
A. Everything(x) is a butterfly(x) and is in Irvine(x) and is pretty(x).
B. There is something(x) that is a butterfly(x) and is in Irvine(x) and is pretty(x).
C. Correct.
D. Vacuously true if anything(x) is not a butterfly(x).

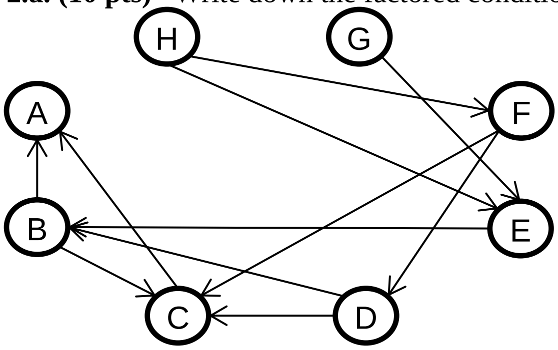
1.g **“Every butterfly likes some flower.”**
A. Vacuously true if there is anything(y) that is not a flower(y).
B. Everything(x) is a butterfly(x) and there is some flower(y) and x likes y.
C. Everything(x,y) is a butterfly(x) and is a flower(y) and x likes y.
D. Correct.

1.h **“Some butterfly likes some flower.”**
A. Correct.
B. Vacuously true if there is anything(x,y) that is not a butterfly(x) or is not a flower(y).
C. Vacuously true if there is anything(x) that is not a butterfly(x).
D. Everything(x,y) is a butterfly and is a flower(y) and x likes y.

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

2. (30 pts total, 10 pts each) BAYESIAN NETWORKS.

2.a. (10 pts) Write down the factored conditional probability expression corresponding to this Bayesian Network:

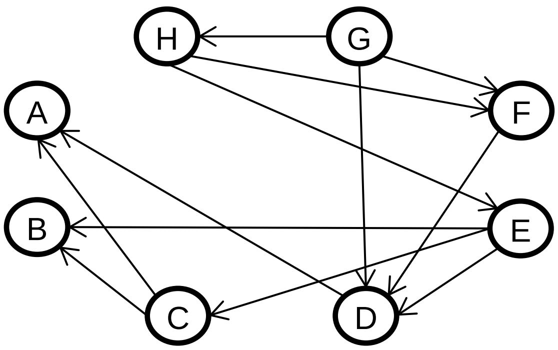


See Section 14.1-4.

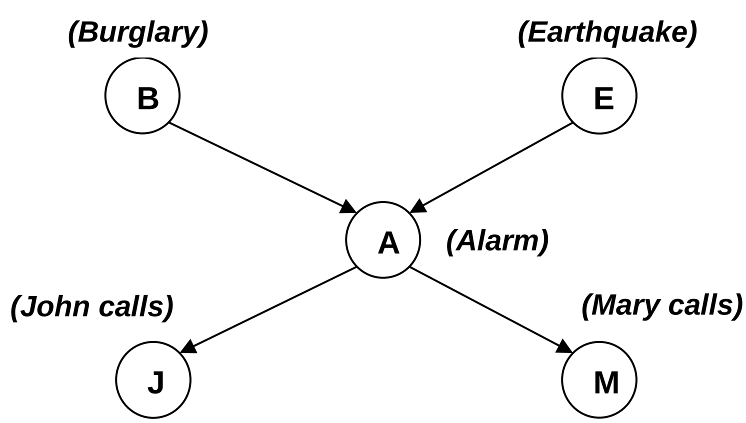
P(A | B, C) P(B | D, E) P(C | B, D, F) P(D | F) P(E | G, H) P(F | H) P(G) P(H)

2.b. (10 pts) Draw the Bayesian Network corresponding to this factored conditional probability expression:

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



2.c. (10 pts) Shown below is the Bayesian network corresponding to the Burglar Alarm problem, i.e., P(J,M,A,B,E) = P(J | A) P(M | A) P(A | B, E) P(B) P(E). This is Fig. 14.2 in your R&N textbook.



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 ∧ M=t ∧ A=t ∧ B=t ∧ 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, first as the symbolic conditional probabilities from the graphs, then as the corresponding numeric probabilities from the tables above.**

P(J=f ∧ M=t ∧ A=t ∧ B=t ∧ E=f)

[put symbolic here] = P(J=f | A=t) * P(M=t | A=t) * P(A=t | B=t ∧ E=f) * P(B=t) * P(E=f)

[put numeric here] = .10 * .70 * .94 * .001 * .998

Note:
P(E=f) = [1 – P(E=t)] = [1 – .002)] = .998
P(J=f | A=t) = [1 – P(J=t | A=t)] = .10