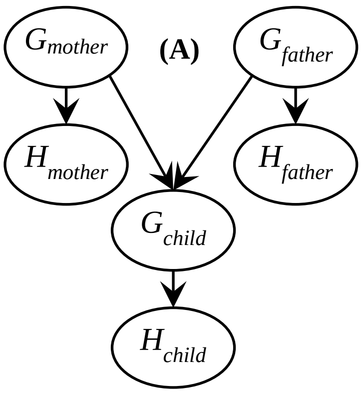
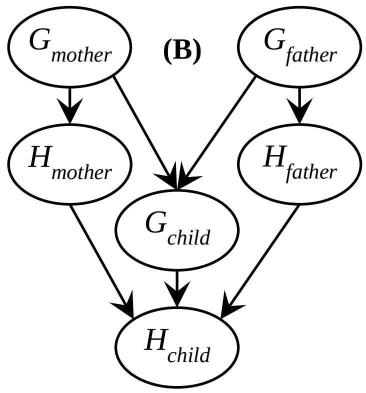
CS-171, Intro to A.I. — Quiz#4 — Winter Quarter, 2018 — 20 minutes

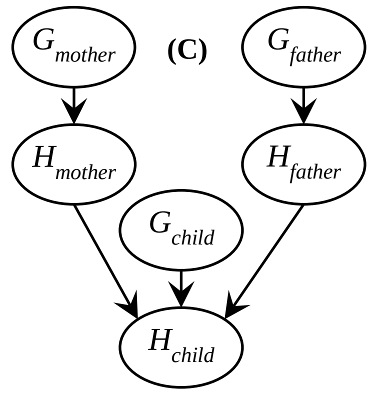
YOUR NAME AND EMAIL ADDRESS: ____

YOUR ID: ____________ ID TO RIGHT: _____________ ROW: _________ SEAT: _________

1. (35 pts total, 5 pts each) Bayesian Networks. (Adapted from Exercise 14.6 in R&N.) Let H_x be a random variable denoting the handedness of an individual *x*, with possible values *l* or *r*. A common hypothesis is that left- or right-handedness is inherited by a simple mechanism; that is, perhaps there is a gene G_x, also with values *l* or *r*, and perhaps actual handedness turns out mostly the same (with some probability *s*) as the gene an individual possesses. Furthermore, perhaps the gene itself is equally likely to be inherited from either of the individual's parents, with a small nonzero probability *m* of a random mutation flipping the handedness. Consider these three networks:







1.a. (5 pts) Which networks above claim that **P**(G_{father}, G_{mother}, G_{child}) = **P**(G_{father}) **P**(G_{mother}) **P**(G_{child}) ?

Write as many of the letters A, B, and C as apply. ________C________________________

1.b. (5 pts) Which networks make independence claims that are consistent with the stated hypothesis?

Write as many of the letters A, B, and C as apply. ________A, B________________________

1.c. (5 pts) Which single network is the best description of the hypothesis?

Write **one** of the letters A, B, and C. _______A_________________________

1.d. (5 pts) How many parameters (probabilities) are needed for the joint distribution **P**(G_{father}, G_{mother}, G_{child})?

Write your answer as a positive integer. __________7 (= $2^3 - 1$); 8 (= 2^3) also will be accepted as correct

1.e. (… r. ________12________

1.f. (… . ________18________

1.g. (… r. ________15________

1.e. (network A) 12 = 1 each for P(G_{mother}) & P(G_{father}); 2 each for P(H_{mother}| G_{mother}), P(H_{father}| G_{father}), & P(H_{child}| G_{child}); and 4 for P(G_{child}| G_{mother}, G_{father}).

1.f. (network B) 18 = 1 each for P(G_{mother}) & P(G_{father}), 2 each for P(H_{mother}| G_{mother}) & P(H_{father}| G_{father}); 4 for P(G_{child}| G_{mother}, G_{father}); and 8 for P(H_{child}| G_{child}, H_{mother}, H_{father}).

1.g. (network C) 15 = 1 each for P(G_{mother}), P(G_{father}), & P(G_{child}) 2 each for P(H_{mother}| G_{mother}) & P(H_{father}| G_{father}); and 8 for P(H_{child}| G_{child}, H_{mother}, H_{father}).

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2. (35 pts total, 5 pts each) The Knowledge Engineering process. Your book identifies seven sequential steps in the knowledge engineering process, which are given below. Unfortunately, the order of the steps has been scrambled. Please, straighten them out.

See Section 8.4

C. Identify the task
G. Assemble the relevant knowledge
E. Decide on a vocabulary of predicates, functions, and constants
D. Encode general knowledge about the domain
B. Encode a description of the specific problem instance
A. Pose queries to the inference procedure and get answers
F. Debug the knowledge base

Fill in the blanks with the letters A, B, C, D, E, F, and G, all in the proper sequence.

___C___ ___G___ ___E___ ___D___ ___B___ ___A___ ___F___.

2. (30 pts total, 5 pts each) Logic-To-English. For each of the following FOPC sentences on the left, write the letter corresponding to the best English sentence on the right. Use these intended interpretations: (1) “Butterfly(x)” is intended to mean “x is a butterfly.” (2) “Flower(x)” is intended to mean “x is a flower.” (3) “FeedsOn(x, y)” is intended to mean “x feeds on y.”

D	$\forall b\ \exists f\ Butterfly(b) \Rightarrow [\ Flower(f) \land FeedsOn(b, f)\ ]$	A	Every butterfly feeds on every
F	$\exists f\ \forall b\ Flower(f) \land [\ Butterfly(b) \Rightarrow FeedsOn(b, f)\ ]$	B	For every flower, there is som butterfly who feeds on that flo
B	$\forall f\ \exists b\ Flower(f) \Rightarrow [\ Butterfly(b) \land FeedsOn(b, f)\ ]$	C	There is some butterfly who feeds on some flower.
E	$\exists b\ \forall f\ Butterfly(b) \land [\ Flower(f) \Rightarrow FeedsOn(b, f)\ ]$	D	For every butterfly, there is so flower that the butterfly feeds
A	$\forall b\ \forall f\ [\ Butterfly(b) \land Flower(f)\ ] \Rightarrow FeedsOn(b, f)$	E	There is some butterfly who feeds on every flower.
C	$\exists b\ \exists f\ Butterfly(b) \land Flower(f) \land FeedsOn(b, f)$	F	There is some flower that every butterfly feeds on.

See Section 8.2.6

Note that $\Rightarrow$ is the natural connective to use with $\forall$.

Note that $\land$ is the natural connective to use with $\exists$.