

CS-171, Intro to A.I. — Quiz #4 — Fall Quarter, 2017 — 20 minutes

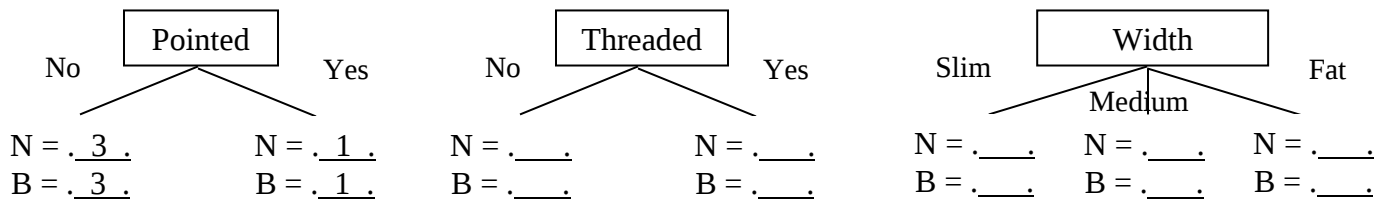
YOUR NAME AND EMAIL ADDRESS: _____

YOUR ID: _____ ID TO RIGHT: _____ ROW #: _____ SEAT #: _____

1. (60 pts total) Learning Decision Trees. You are a robot in the fasteners section of a hardware store and must learn to discriminate Nails from Bolts. You choose to learn a Decision Tree classifier from various nails and bolts that you have observed. Unfortunately, your sensors are noisy, and so your training data has a few errors. This table summarizes the noisy, error-prone data you have accumulated for training:

Example	Pointed	Threaded	Width	Class
Example #1	No	Yes	Slim	Nail
Example #2	No	Yes	Slim	Nail
Example #3	No	No	Medium	Nail
Example #4	Yes	Yes	Fat	Nail
Example #5	Yes	Yes	Medium	Bolt
Example #6	No	Yes	Fat	Bolt
Example #7	No	Yes	Medium	Bolt
Example #8	No	No	Fat	Bolt

1.a. (10 pts total, 5 pts each) Root Variable Selection. For each possible choice of the root variable, indicate how it would partition the examples. Write your answer as the number of Nails (N= ____) and Bolts (B= ____) in each partition. **The first one is done for you as an example.**



1.b. (10 pts) Which attribute would information gain choose as the root of the tree?

Full credit if your answer is right for the partitions you gave in 1.a, even if 1.a was wrong.

1.c. (20 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.

Full credit if your answer is right for the root you chose in 1.b, even if 1.b was wrong.

Classify these new examples as Nail or Bolt using your decision tree above.

1.d. (10 pts) What class is [Pointed=No, Threaded=No, Width=Slim]? _____

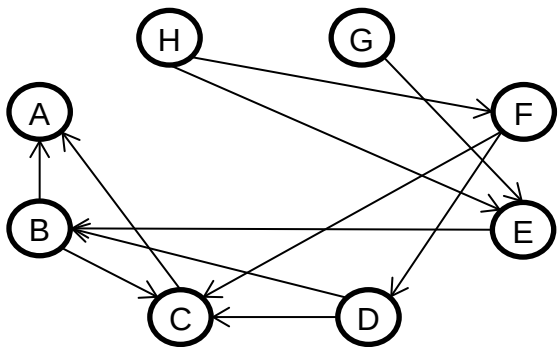
1.e. (10 pts) What class is [Pointed=No, Threaded=No, Width=Fat]? _____

**** TURN PAGE OVER AND CONTINUE ON THE OTHER SIDE *

Full credit if your answers are right for the tree you drew in 1.c, even if 1.c was wrong.

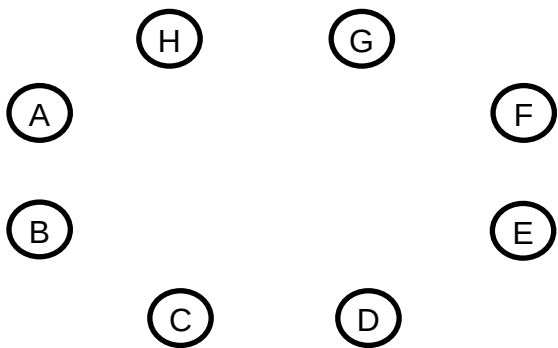
2. (40 points total, 10 pts each) Bayesian Networks.

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



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. (20 pts total, 10 pts each) Below is the Bayesian network for the WetGrass problem [Fig. 14.12(a), R&N].

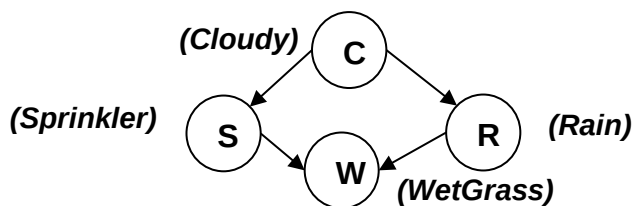
Write down a numerical expression that will evaluate to $P(C=f \wedge R=f \wedge S=t \wedge W=t)$.

First line (1): Convert the conjunction into a symbolic factored conditional probability formula according to the network.

Second line (2): Substitute numerical probabilities from the tables to yield numbers separated by multiplication symbols.

Remember that the tables show the probability that each variable is True, e.g., $P(C)$ means $P(C=t)$.

You do not need to do the multiplications to produce a number (the probability).



P(C)
.5

C	P(S)
t	.1
f	.5

C	P(R)
t	.8
f	.2

S	R	P(W)
t	t	.99
t	f	.90
f	t	.90
f	f	.00

$$P(C=f \wedge R=f \wedge S=t \wedge W=t)$$

(1) =

(2) =

Full credit for (2) if your answer is right for the formula you gave in (1), even if (1) was wrong. Trivial answers to (1) are excluded.