

# 10-701/15-781 Machine Learning, Fall 2003

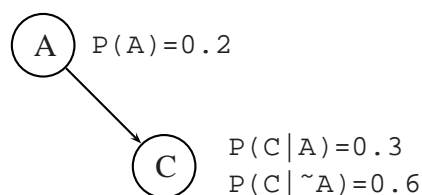
## Homework 5

Out: Nov 4, 2003

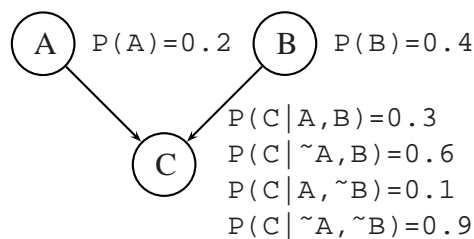
Due: start of class Nov 11, 2003

If you have questions, please contact Jiayong Zhang <zhangjy@cs.cmu.edu>.

1. (40pts, Evaluation) For (a)-(e), compute the following probabilities from the given Bayes nets. These examples have been designed so that none of the calculations should take you longer than a few minutes. If you find yourself doing dozens of calculations on a question sit back and look for shortcuts.

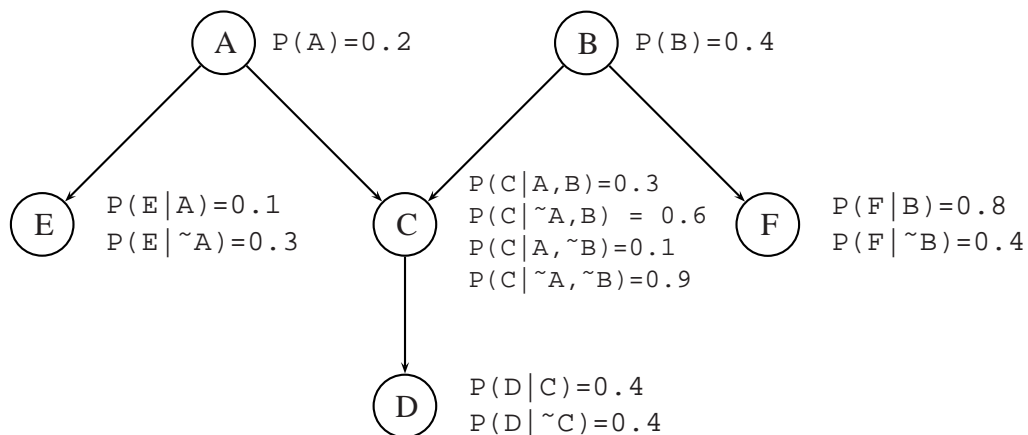


(a)  $P(A|C) =$

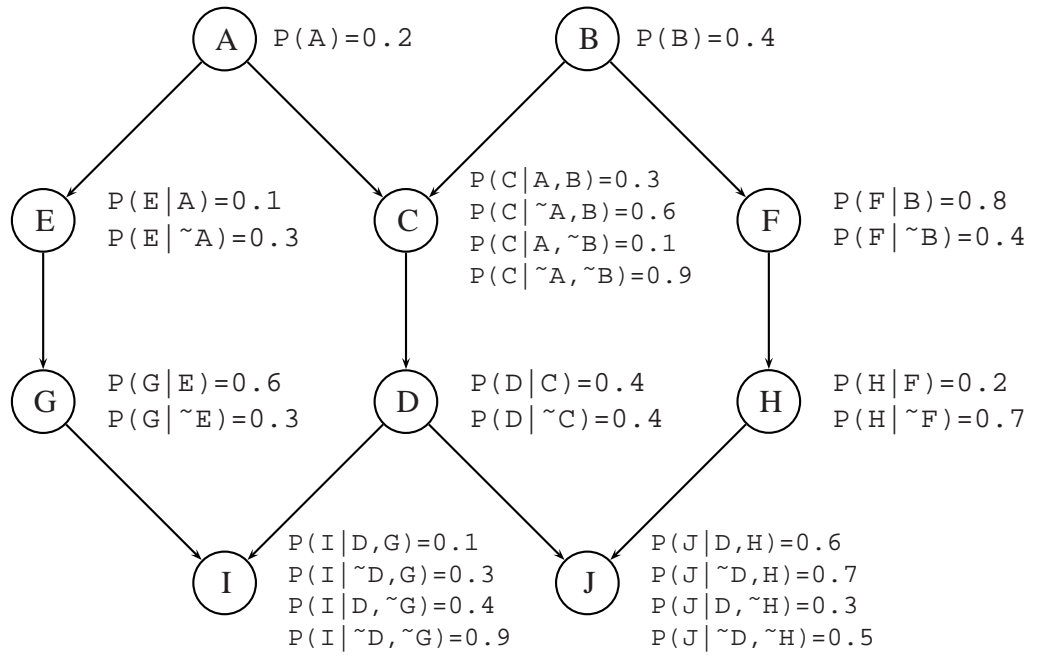


(b)  $P(\sim A|B) =$

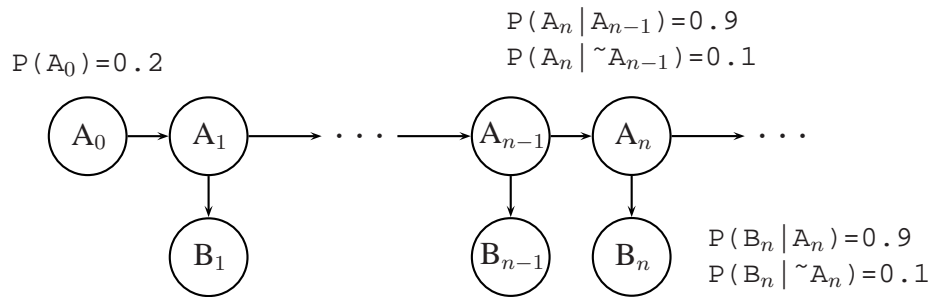
(c)  $P(\sim A|B, \sim C) =$



(d)  $P(E|D) =$



(e)  $P(\sim G|\sim J) =$

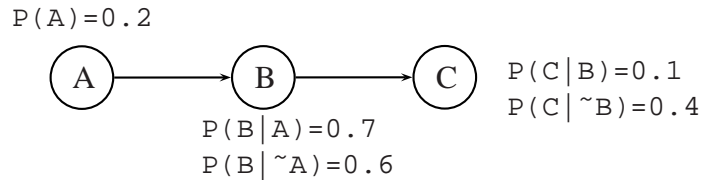


Let  $q_n = P(A_n | B_1, B_2, \dots, B_n)$ .

(f) Compute  $q_n$  in terms of  $q_{n-1}$ .

(g) What is  $\lim_{n \rightarrow \infty} q_n$ ?

2. (30 pts, Likelihood Weighting) For this part, you will be writing a program to compute the approximate probabilities of events given a particular Bayes net. You are asked to use the approach of likelihood weighting described in your class notes. As an example, we can estimate  $P(A|C)$  in the following Bayes net.



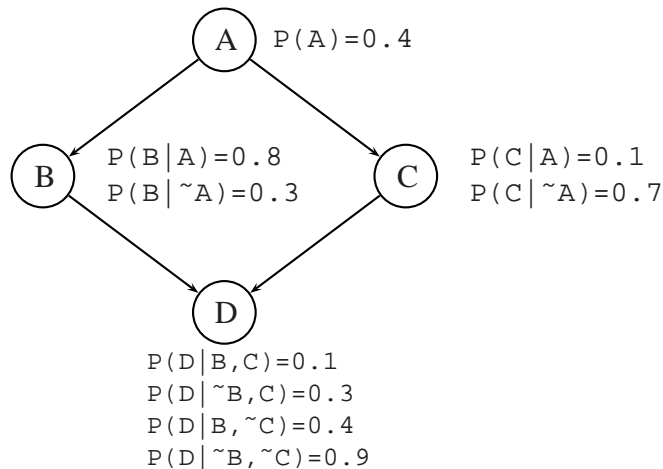
A C-code implementation `example.c` is provided. The program can be compiled from `gcc` on UNIX/LINUX machines with

```
gcc -o example example.c -lm
```

and then runs as

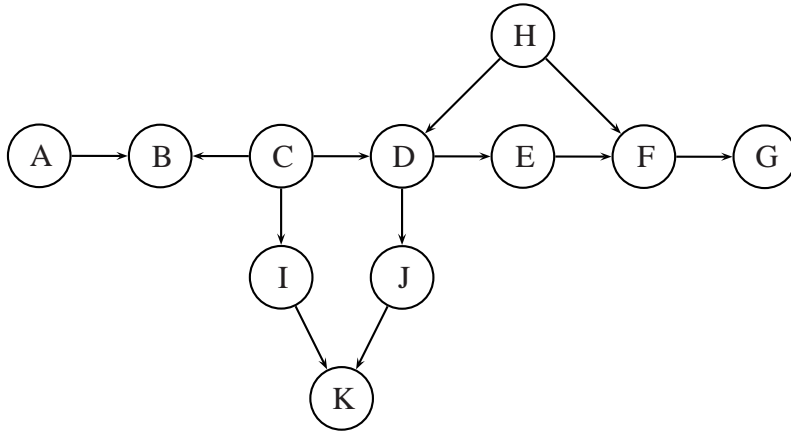
```
./example <num_samples>
```

Now consider the following Bayes net.



- Hand in source code similar to the example that computes  $P(B|C)$  using likelihood weighting. You may use `example.c` and modify for your own answer if you wish. Or you can use any other language you prefer.
- Plot the average absolute estimation error versus the number of samples.

3. (30 pts, D-separation) Using the given Bayes network, for each of the following statements indicate whether it is true or false.



- (a)  $I \langle A, B, C \rangle$
- (b)  $I \langle D, E, F \rangle$
- (c)  $I \langle A, \{\}, D \rangle$
- (d)  $I \langle B, \{\}, I \rangle$
- (e)  $I \langle B, D, J \rangle$
- (f)  $I \langle C, \{G\}, H \rangle$
- (g)  $I \langle I, J, H \rangle$
- (h)  $I \langle A, \{B, E\}, G \rangle$
- (i)  $I \langle K, \{\}, G \rangle$
- (j)  $I \langle C, \{\}, H \rangle$