CS440: Introduction to Artificial Intelligence
Fall 2008
Programming Assignment #3: Clue as a Bayesian Net
Due Thursday, Dec. 11th, at noon.

Introduction

In the previous programming assignment, you wrote a resolution theorem prover for the child's game of *Clue*. But of course, *Clue* is a game; everything is either true or false. In real life, there is uncertainty. So in this assignment we will use the game of *Clue* as a domain, but this time the goal is to infer the probability of an even given a set of evidence. The method of inference should be variable elimination over a (small) Bayesian net.

The Problem

In the game of Clue, there are three explicit random variables: Person (Mustard, Scarlett, Plum, Green, White, Peacock), Weapon (Wrench, Candlestick, Rope, Knife, Revolver, Pipe), and Room (Hall, Lounge, Dining, Kitchen, Ballroom, Conservatory, Billiard, Library, Study). Looking at crime statistics (well, pretending to) we have also determined that we need three implicit random variables: Gender (M, F), Cook (T, F) and Military(T, F). The motivation for the additional variables is as follows: women stereotypically prefer certain types of weapons (e.g. knives), while men prefer others (e.g. revolvers, pipes and wrenches). Cooks are more likely to be in the kitchen and to have access to knives. (From her outfit, we infer that Mrs. White is more likely than the others to be a cook, although academics also tend to like to cook, so Prof. Plum is slightly more likely to be a cook than the others.) Current and former members of the military are trained to use guns. (Note that we don't know if Col. Mustard was in the military or if his moniker is just an affect, but we will infer that it is more likely.) The Bayesian net that relates these six variables is given in Figure 1, below. The conditional probability tables are also given below.

Your job is to write a program that takes in evidence and a query variable assignment, and prints out the probability of the query variable assignment given the evidence. The evidence consists of assignments for any subset of variables (including the empty set and the full set). The query variable assignment is the target that you are calculating the probability of. For example, you might get the following input:

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Cook = F
Weapon = Knife
Query = Room = Library
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Your program should then print out probability that the murder was committed in the library, given that the murderer was a cook and the murder weapon was a knife.

Input

Your program should take the name of an input file as its only argument. The file will be an input file. The last line of the file will contain a query variable. Any preceding lines will contain evidence variables. An evidence variable line will be of the form "Variable = Value", as in the example above. Note that the variable names, equal signs and values are separated by a space, and that there is only one variable per line. The values for Gender are M and F. The values for

Cook and Military are T and F. The values for Person, Weapon and Room are the same as in the last assignment. The last line contains the query variable, which is of the form "Query = Variable = Value", as in the example above.

Output

Your program should write a single number (between 0 and 1) to standard out. This variable should be the probability of the query assignment given the evidence provided.

Late Policy

Assignments are due when they are due; late assignments are not accepted. I know I said this last time, and then gave the class an extension (you seemed to need it). This time there can be no extension, because by university policy I cannot accept assignments after the end of classes.

There is a departmental exception for "unforeseeable circumstances". Examples include medical emergencies, family tragedies, fires, etc. If such an unforeseeable circumstance happens to you, please talk to the instructor. We will work with you on a case-by-case basis.

As always….

All work must be your own. You may not copy code from the internet, your colleagues or anyone else. See the department cheating policy.

Conditional Probabilities

Here are the conditional probability tables for your Bayesian network:

Gender	
M	F
0.6	0.4

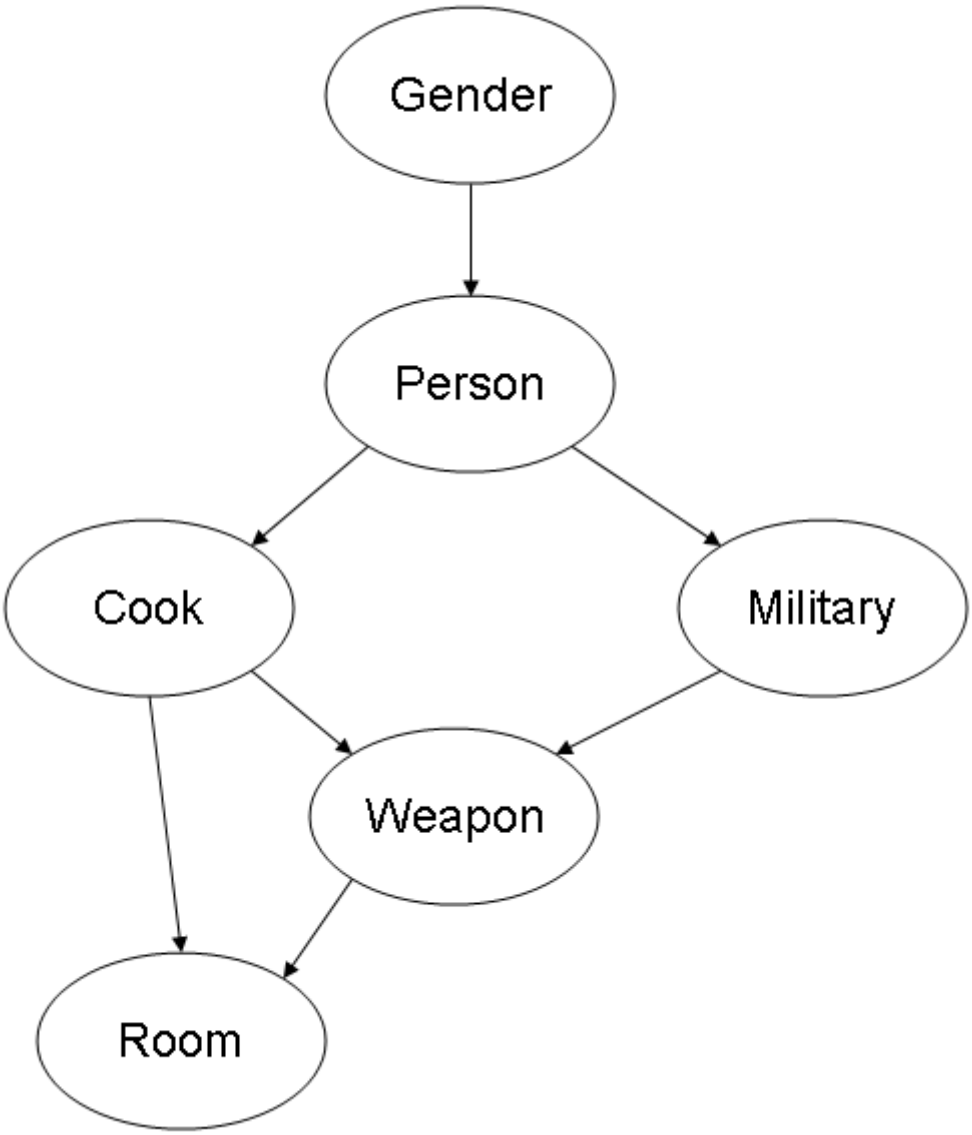
Person						
Gender	P(Scarlett)	P(White)	P(Peacock)	P(Mustard)	P(Green)	P(Plum)
M	0.0	0.0	0.0	0.333	0.333	0.333
F	0.333	0.333	0.333	0.0	0.0	0.0

Cook		
Person	P(T)	P(F)
Scarlet	0.5	0.5
White	0.9	0.1
Peacock	0.5	0.5
Mustard	0.5	0.5
Green	0.5	0.5
Plum	0.6	0.4

Military		
Person	P(T)	P(F)
Scarlet	0.25	0.75
White	0.25	0.75
Peacock	0.25	0.75
Mustard	0.75	0.25
Green	0.25	0.75
Plum	0.25	0.75

Weapon							
Cook	Mil	P(Knife)	P(Revolver)	P(Rope)	P(Wrench)	P(Candlestick)	P(Pipe)
T	T	0.25	0.25	0.125	0.125	0.125	0.125
T	F	0.9	0.02	0.02	0.02	0.02	0.02
F	T	0.20	0.30	0.125	0.125	0.125	0.125
F	F	0.2	0.2	0.2	0.10	0.10	0.2

Room										
Cook	Weapon	P(Hall)	P(Lng)	P(Kitch)	P(Ball)	P(Cons)	P(Bill)	P(Lib)	P(Std)	P(Dine)
T	Knife	0.01	0.01	0.65	0.10	0.01	0.01	0.01	0.10	0.10
T	Revolver	0.01	0.01	0.35	0.20	0.01	0.01	0.01	0.20	0.20
T	Rope	0.01	0.01	0.35	0.20	0.01	0.01	0.01	0.20	0.20
T	Wrench	0.01	0.01	0.35	0.20	0.01	0.01	0.01	0.20	0.20
T	Candle	0.01	0.01	0.35	0.20	0.01	0.01	0.01	0.20	0.20
T	Pipe	0.01	0.01	0.35	0.20	0.01	0.01	0.01	0.20	0.20
F	Knife	0.1	0.1	0.15	0.1	0.1	0.1	0.1	0.1	0.15
F	Revolver	.12	.11	.11	.11	.11	.11	.11	.11	.11
F	Rope	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1
F	Wrench	0.2	0.05	0.15	0.1	0.15	0.1	0.1	0.1	0.05
F	Candle	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
F	Pipe	0.2	0.1	0.15	0.05	0.15	0.05	0.1	0.1	0.1


Gender
Person
Cook
Military
Weapon
Room