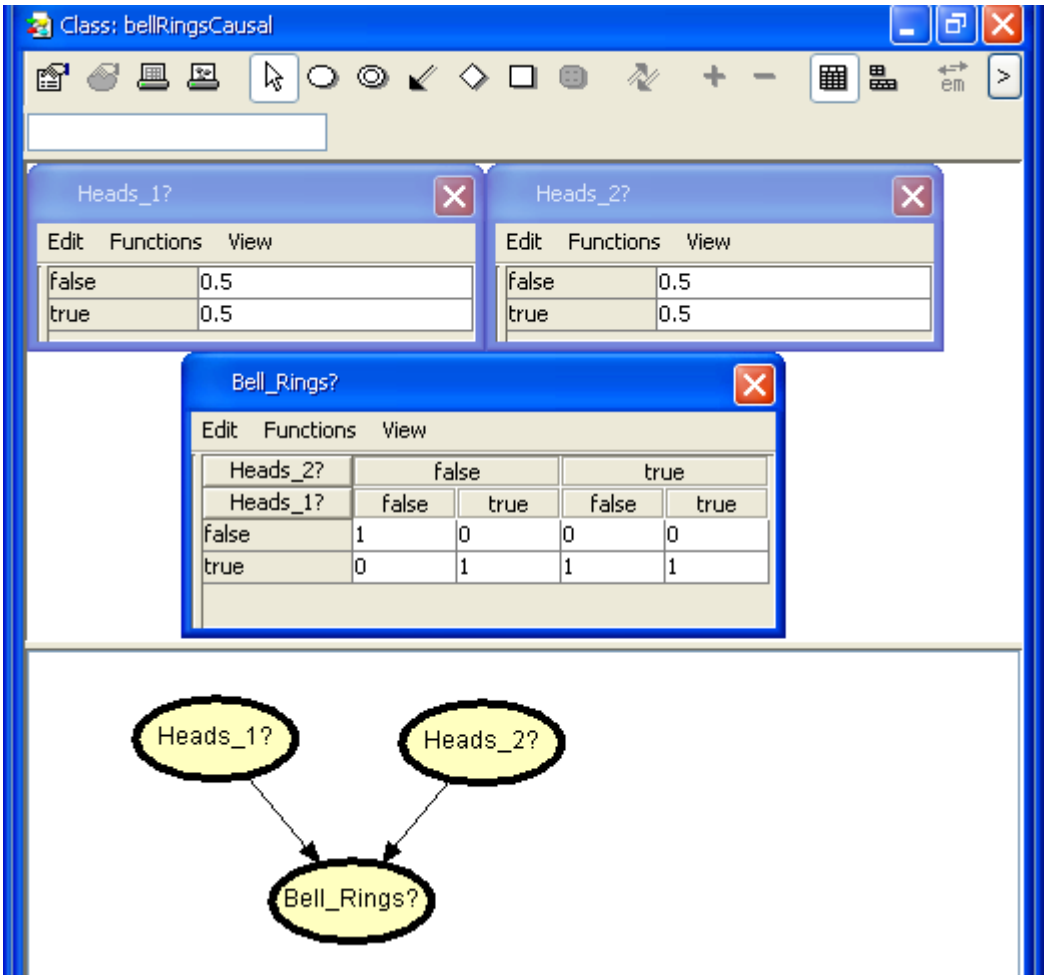
CSCE 582 Spring 2009

Test 1

2009-02-18

Closed book and notes

Consider the following simple Bayesian network. The network describes a situation in which a bell rings if and only if either one of two fair coins turns up heads.



(1—10 points) Fill the d-separation column in the table below.

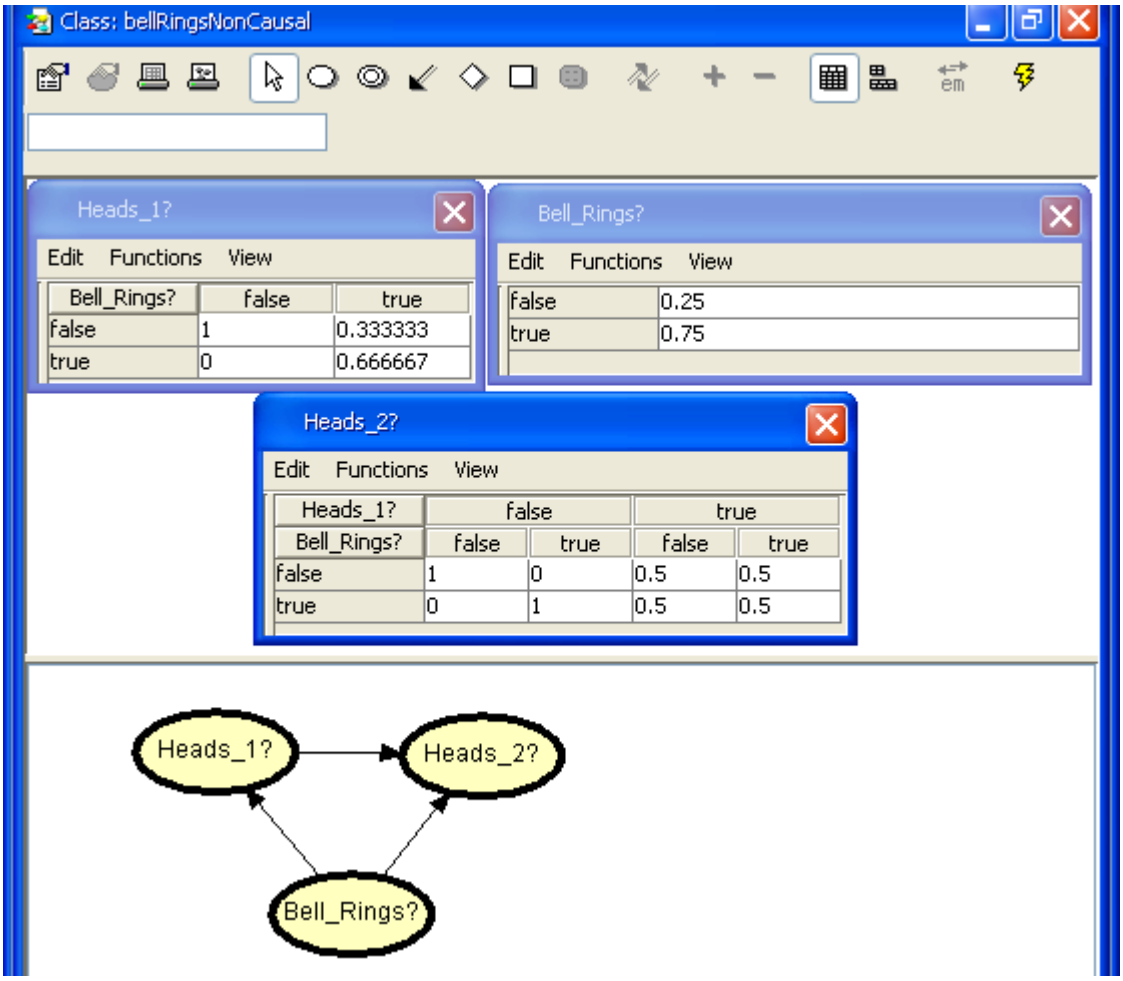
Variables	**d-separated?**	**independent?**
Heads1?, Bell_Rings?	No	No
Heads2?, Bell_Rings?	No	No
Heads1?, Heads2?	Yes	Yes
Heads1?, Heads2? **given** *Bell_Rings?*	No	No

(2—10 points Compute the joint probability *P(Heads1?, Heads2?, Bell_Rings?)* by filling in the following table. The first entry is given to you.

Heads1?	***Heads2?***	***Bell_Rings?***	***P(Heads1?, Heads2?, Bell_Rings?)***
F	F	F	***0.5*0.5*1 = 0.25***
F	F	T	0.5*0.5*0 = 0
F	T	F	0.5*0.5*0 = 0
F	T	T	0.5*0.5*1 = 0.25
T	F	F	0.5*0.5*0 = 0
T	F	T	0.5*0.5*1 = 0.25
T	T	F	0.5*0.5*0 = 0
T	T	T	0.5*0.5*1 = 0.25

(3—10 points) Use the table above to determine whether *Heads1?* is independent of *Heads2?* given *Bell_Rings?*. Complete the independence column in the table on the first page.

Now consider the following Bayesian network, which has the same variables as the previous one.



(4—10 points) Fill the d-separation column in the table below.

Variables	**d-separated?**	**independent?**
Heads1?, Bell_Rings?	No	No
Heads2?, Bell_Rings?	No	No
Heads1?, Heads2?	No	Yes
Heads1?, Heads2? **given** *Bell_Rings?*	No	No

(5—10 points Compute the joint probability *P(Heads1?, Heads2?, Bell_Rings?)* by filling in the following table. The first entry is given to you.

Heads1?	***Heads2?***	***Bell_Rings?***	***P(Heads1?, Heads2?, Bell_Rings?)***
F	F	F	***1*1*0.25= 0.25***
F	F	T	0.333*0*0.25 = 0
F	T	F	1*0*0.25 = 0
F	T	T	0.333*1 0.75= 0.25
T	F	F	0*0.5*0.25 = 0
T	F	T	0.667*0.5*0.75 = 0.25
T	T	F	0*0.5*.25 = 0
T	T	T	0.667*0.5*0.75 = 0.25

(6—10 points) Use the table above to determine whether *Heads1?* is unconditionally independent of *Heads2?*. Complete the independence column in the table on the first page.

Possible answers for the first question: (1) the joint probability table above is the same as the JPT for part 2, so the same independence relations hold. (2) show that P(Heads1?, Heads2?) = P(Heads1?) * P(Heads2?).

(7—10 points) Here is an example from Greg Cooper via Richard Neapolitan. Suppose that metastatic cancer is a cause of brain tumor and can also cause an increase in total serum calcium. Suppose further that either a brain tumor or an increase in total serum calcium could cause a patient to fall into a coma, and that a brain tumor could cause papilledema.

Draw a causal network representing the example. Use only the following five binary variables: MetastaticCancer (present/not present), SerumCalcium (increased/not increased), BrainTumor (present/not present), Coma (present/not present), Papilledema (present/not present).

Check that in your network SerumCalcium and BrainTumor are d-separated by MetastaticCancer but are d-connected given Coma and any superset of {Coma}. Also check that BrainTumor d-separates Papilledema from the other variables.

Answer: