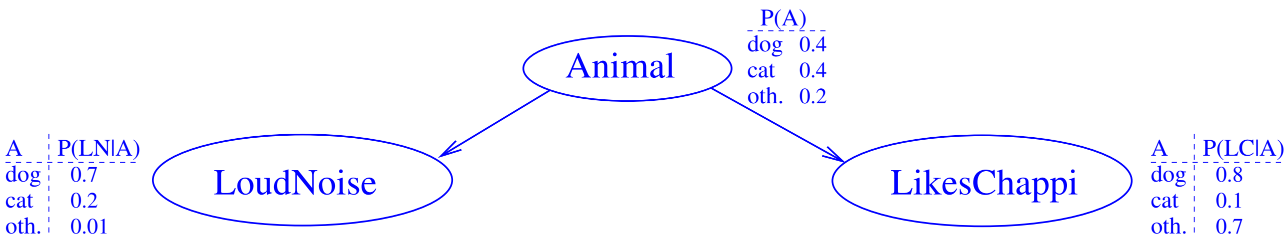
Exercise 1 :

Consider the following Bayesian network BN:



Use inference by enumeration to compute the following probabilities:

(a) $P(dog \mid loudnoise, likeschappi)$.

(b) $P(loudnoise \mid \neg likeschappi)$.

Include intermediate steps at a level of granularity as in the lecture slides examples. In particular, for each of (a) and (b), state what the query variable, evidence, and hidden variables are; and write down *which* probabilities provided in BN can be combined *how* to obtain the demanded probability P.

Exercise 2 :

Consider the running example of the lecture with the following probability tables:

	Burglary	
	t	*f*
	.1	.9

	Earthquake	
	t	*f*
	.1	.9

		Alarm	
Burglary	Earthquake	*t*	*f*
t	*t*	.9	.1
t	*f*	.8	.2
f	*t*	.5	.5
f	*f*	.1	.9

	JohnCalls	
Alarm	*t*	*f*
t	.8	.2
f	.1	.9

	MaryCalls	
Alarm	*t*	*f*
t	.7	.3
f	.1	.9

Use Variable Elimination to determine the conditional probability $P(MC \mid B = t)$. For each step indicate the operations that are performed over the previous factors and what new factor is computed.

Exercise 3 :

* Complete Exercise 8.10 in PM.

Exercise 4 :

Consider the network defined by the two binary variables A and B, where A is the parent of B. Assume that the conditional probability tables are given as $P(A) = (0.1, 0.9)$ and

	A	
	a_1	a_2
b_1	0.05	0.2
b_2	0.95	0.8

i) Assume that you want to estimate $P(b_1)$ using sampling. How many samples would be required if you only accept an error larger than 0.15 in 10% of the cases?

ii) Generate two random samples, using the following list of random numbers (any time that you use a random number pick one from the list): $0.5, 0.3, 0.01, 0.8$.

iii) Suppose that after sampling 10 states, you got $(A = a_2, B = b_2)$ 3 times, and $(A = a_1, B = b_2)$,6 times, and $(A = a_1, B = b_1)$ once. Estimate $P(B = b_1)$

iv) (Optional) Implement the network above in Hugin and use Hugin to sample the number of cases that you calculated in step (i); use the function 'Simulate cases' under 'File'. Use the sampled cases to estimate $P(b_1)$ and compare the result with Hugin. Feel free to use a spreadsheet for the counting.

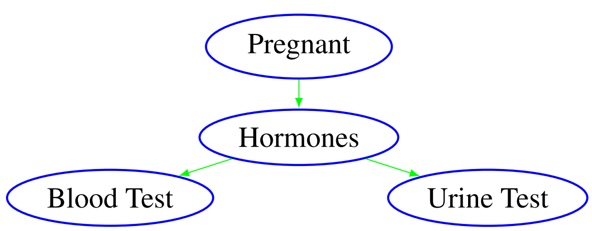
v) Assume that you want to use rejection sampling to estimate $P(A|B = b_1)$. How many samples do you expect you would have to generate in order to end up (after rejection) with a sample set of 1000 cases for estimating the probability.

Exercise 5 :

Complete Exercise 8.6(a-b) in PM.

Exercise 6 :

Consider the insemination example from Section 3.1.13 in BNDG:



Let the probabilities be as in Table 1 (*Ho* $= y$ means that hormonal changes have taken place) $P(Pr) = (0.87, 0.13)$.

	$Pr = y$	$Pr = n$
$Ho = y$	0.9	0.01
$Ho = n$	0.1	0.99

	$Ho = y$	$Ho = n$
$BT = y$	0.7	0.1
$BT = n$	0.3	0.9

	$Ho = y$	$Ho = n$
$UT = y$	0.8	0.1
$UT = n$	0.2	0.9

Table 1: Tables for Exercise 6.

i) What is $P(Pr \mid BT = n, UT = n)$?

ii) Construct a naive Bayes model. Determine the conditional probabilities for the model by making inference queries in the model above using Hugin. What is $P(Pr \mid BT = n, UT = n)$ in this model and how does it compare to the result you got above? Try to (qualitatively) account for any differences.

iii) (Optional) Verify your solution modelling both BNs in Hugin.