10-601 Machine Learning: Assignment 5

- The assignment is due at 3:00pm (beginning of class) on **Monday, March 3, 2008**.
- Since you only have one week, it will be worth **40 points**.
- Write your name at the top right-hand corner of each page submitted.
- Each student must hand in a hard-copy writeup. See the course webpage for collaboration policies.

Q1: Representing and learning Bayes nets [25 pts]

1. Download JavaBayes from here: `http://www.cs.cmu.edu/~javabayes/`. To run JavaBayes, go into the Classes directory and run `java JavaBayes`.
2. Load the JohnMaryCall network into JavaBayes.
3. Using the "Edit Function" button, look at the CPT's of the various nodes (by clicking on the nodes and then hitting "Dismiss" to close without changing the CPT). Based on these probability tables, what is the joint probability of {**Burglary=True**, **Earthquake=False**, **Alarm=True**, **JohnCall=True**, **MaryCall=True**}?
4. Try querying each node, and note the initial posterior probabilities on each. Now observe **Alarm=True** (by using the Observe button and clickin on **Alarm**). How do the posterior probabilities of the other variables change? Explain why (or why not).
5. Now, with **Alarm=True**, observe **Earthquake=True**. What happens to the posterior probability of **Burglary**? What happens to the posterior probability of **JohnCall**? Explain the results.
6. Set **Earthquake** to unobserved. Now observe **JohnCall=True**. What happens to the posterior probability of **MaryCall**? What about the posterior probability of **Earthquake**? Explain.

Q2: D-separation [15 pts]

1.
   (a) Draw **all** 4-node Bayesian networks that are consistent with **at least** both of the following conditional independencies: $(A \perp B|C)$, $(D \perp A, B|C)$.
   (b) How many different graphs did you draw?
   (c) Why might you prefer one of these graphs to the others?
2.

(a) Write all the conditional independencies you can read off this graph in the form $(X \perp Y | \mathbf{Z})$, where X and Y are single variables and $\mathbf{Z}$ is any set of variables, including the empty set: