CPSC 420-500 Homework #3
Due 11/11/08 (Tuesday) in class

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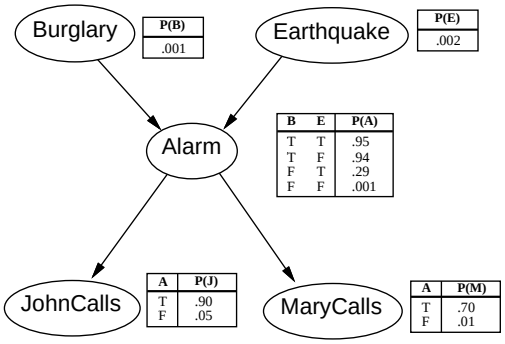
1 Theorem Proving in First-Order Logic

Question 1 (15 pts): Show that $R(A)$ is a logical consequence of the following. Use **resolution** (w, x, y, z are variables, and A is a constant).

1. $\neg P(x) \rightarrow [Q(x, y) \vee R(y)]$
2. $\neg P(A)$
3. $\neg Q(w, z) \vee R(w)$

2 Uncertainty and Probabilistic Reasoning

Question 2 (15 pts): Given the belief network as shown below, calculate the joint probability $P(\neg JohnCalls \wedge MaryCalls \wedge Alarm \wedge \neg Earthquake \wedge Burglary)$.



3 Learning

3.1 Decision Tree Learning

Consider the following set of examples where you are trying to make a decision whether to buy a robot or not given the specifications in terms of the sensors used (Sensor), number of legs (Legs), and energy source used (Energy).

Example#	Sensor	# Legs	Energy Source	Decision (Buy?)
1	Vision	8	Oil	Y
2	Sonar	8	Solar	N
3	Sonar	8	Food	Y
4	Vision	2	Oil	Y
5	Sonar	2	Oil	N
6	Sonar	2	Sun	Y
7	Thermal	2	Food	N
8	Vision	2	Oil	Y
9	Sonar	2	Food	Y
10	Thermal	8	Sun	N

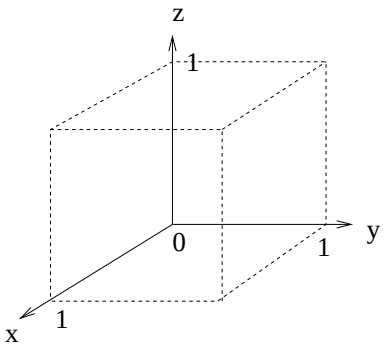
Question 3 (12 pts): For each attribute (Sensor, Legs, Energy), draw a one-depth decision tree. See slide06.pdf, page 12 for an example.

Question 4 (12 pts): For each of the cases above, calculate the information gain.

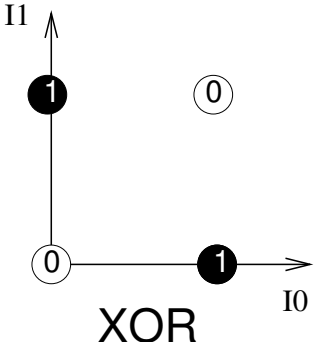
Question 5 (5 pts): Based on the information gain, which attribute would you choose first?

Question 6 (12 pts): Can a single perceptron unit solve the following classification problem?: In other words, can the perceptron learning rule find a set of weights to correctly classify all examples? (1) Answer "yes" or "no" to the question, (2) draw a geometric illustration of the problem in 3D and (3) justify your reasoning.

Input x	Input y	Input z	Class
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0



Question 7 (15 pts): Explain how a backpropagation network with 2 hidden units and one output unit can correctly learn the XOR function. Hint: try illustrating below how two decision boundaries (implemented by the hidden layer neurons) can be combined to give the desired result.



Question 8 (14 pts): What are the two quantitative measures of performance for the Self-Organizing Map? Explain which one of those two relate to *encoding/prototyping* and which one relates to *feature mapping*.