

**CS3243 Foundations of Artificial Intelligence (2005/2006 Semester 2)**  
**Tutorial 10**

1. Assume that the following conditional probabilities are available:

P(Wet_Grass   Sprinkler, Rain)	0.95
P(Wet_Grass   Sprinkler, ¬Rain)	0.9
P(Wet_Grass   ¬Sprinkler, Rain)	0.8
P(Wet_Grass   ¬Sprinkler, ¬Rain)	0.1
P(Sprinkler   Rainy_Season)	0.0
P(Sprinkler   ¬Rainy_Season)	1.0
P(Rain   Rainy_Season)	0.9
P(Rain   ¬Rainy_Season)	0.1
P(Rainy_Season)	0.7

Construct a Bayesian network and determine the probability  
 $P(\text{Wet\_Grass} \wedge \text{Rainy\_Season} \wedge \neg \text{Rain} \wedge \neg \text{Sprinkler})$

2. An expert system called PROSPECTOR for use in geological exploration makes use of an inference mechanism similar to a Bayesian network. The following are two modified versions of its rule patterns:

*If*  $E_1$   
*Then*  $H_1$  ( $P(H_1|E_1), P(H_1|\neg E_1)$ )

*If*  $E_2$   
*and*  $E_3$   
*Then*  $H_2$  ( $P(H_2|E_2 \wedge E_3), P(H_2|E_2 \wedge \neg E_3), P(H_2|\neg E_2 \wedge E_3), P(H_2|\neg E_2 \wedge \neg E_3)$ )

The following is a hypothetical set of PROSPECTOR's rules (where we also use two letters to represent propositions for your easy working later)

*If* the igneous rocks in the region have a fine to medium grain size (Gr)  
*Then* they have a porphyritic texture (Tx) (0.6, 0.2)

*If* the igneous rocks in the region have a fine to medium grain size (Gr)  
*and* they have a porphyritic texture (Tx)  
*Then* the region is a hypabyssal environment (Hy) (0.88, 0.76, 0.52, 0.02)

*If* the region is a hypabyssal environment (Hy)  
*Then* the region has a favourable level of erosion (Er) (0.75, 0.12)

*If* the region has a favourable level of erosion (Er)  
*Then* the region is favourable for copper deposits (Cu) (0.92, 0.03)

Construct a Bayesian network based on the above rules. Assume that a geologist could only ascertain with probability 0.15 that a region's igneous rocks have a fine to medium grain size. What is the probability that this region is favourable for copper deposits and has a favourable level of erosion, given that the region (1) has large grain size igneous rocks, (2) has non-porphyrific texture rocks, and (3) is a hypabyssal environment.

3. The loans department of a bank has the following past loan processing records each containing an applicant's income, credit history, debt, and the final approval decision. These records can serve as training examples to build a decision tree for a loan advisory system.

Income	Credit History	Debt	Decision
\$ 0 – \$ 5K	Bad	Low	Reject
\$ 0 – \$ 5K	Good	Low	Approve
\$ 0 – \$ 5K	Unknown	High	Reject
\$ 0 – \$ 5K	Unknown	Low	Approve
\$ 0 – \$ 5K	Unknown	Low	Approve
\$ 0 – \$ 5K	Unknown	Low	Reject
\$ 5K – \$ 10K	Bad	High	Reject
\$ 5K – \$ 10K	Good	High	Approve
\$ 5K – \$ 10K	Unknown	High	Approve
\$ 5K – \$ 10K	Unknown	Low	Approve
Over \$10K	Bad	Low	Reject
Over \$10K	Good	Low	Approve

Construct a decision tree based on the above training examples.

(Note:  $\log_2 \frac{x}{y} = \log_2 x - \log_2 y$  ,  $\log_2 0 = 0$  ,  $\log_2 1 = 0$  ,  $\log_2 2 = 1$  ,  $\log_2 3 = 1.585$ ,

$\log_2 4 = 2$  ,  $\log_2 5 = 2.322$  ,  $\log_2 6 = 2.585$  ,  $\log_2 7 = 2.807$  ,  $\log_2 8 = 3$  ,  $\log_2 9 = 3.170$  ,  
 $\log_2 10 = 3.322$  ,  $\log_2 11 = 3.459$  ,  $\log_2 12 = 3.585$ )

What is decision tree classifier's decision for a person who has 4K yearly income, a good credit history and a high amount of debt?

4. Construct the probabilities needed for classification based on Naïve Bayes for the above problem. What is the decision of the Bayesian classifier for the same individual in the above example?