Universität des Saarlandes
Fachrichtung 6.2 – Informatik
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10th Theoretical Assignment in Artificial Intelligence (SS 2005)

Issued: July 4, 2005 Due: July 11, 2005

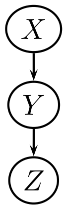
– This exercise sheet will be discussed in a plenary tutorial on –
– wednesday, july 13th 2005 between 16-18 h –
– in lecture hall HS002 –

Exercise 10.1 **(50 P)**

Consider the following Bayesian network with three Boolean random variables X, Y, Z.

$P(X = true) = \frac{1}{2}$

y	$P(Z = true \vert Y = y)$
$true$	$\frac{1}{3}$
$false$	$\frac{1}{2}$



x	$P(Y = true \vert X = x)$
$true$	$\frac{3}{4}$
$false$	$\frac{1}{2}$

Using the Bayesian network above, answer the following questions.

(a) Compute $P(Y = false|X = true)$: the conditional probability that Y is false given that X is true. (5 P)

(b) Compute $P(Y = false|X = false)$: the conditional probability that Y is false given that X is false. (5 P)

(c) Compute $P(X = true, Y = false)$: the probability that X is true and Y is false. (5 P)

(d) Compute $P(X = false, Y = false)$: the probability that X is false and Y is false. (5 P)

(e) Compute $P(Y = false)$: the probability that Y is false. (5 P)

(f) Compute $P(X = true|Y = false)$: the conditional probability that X is true given that Y is false. (5 P)

(g) Compute $P(X = true, Y = false, Z = true)$: the probability that X and Z are true but Y is false. (5 P)

(h) Compute $P(X = true, Z = true)$: the probability that X and Z are true. (5 P)

(i) Compute $P(Y = false|X = true, Z = true)$: the probability that Y is false given that X and Z are true. (5 P)

(j) Does the equation $P(Y = false|X = true, Z = true) = P(Y = false|X = true)$ hold? (5 P)

Exercise 10.2 **(30 P)**

Putting together a decision tree is all a matter of choosing which attribute to test at each node in the tree. In the following exercise, you should calculate the information gain for each attribute of the restaurant domain illustrated in Russell/Norvig.

1. To work out the information gain you, firstly, need to calculate the entropy for the set of examples S. (15 P)
2. For each attribute, use the entropy of S to calculate the information gain. (15 P)

(Note: You should take $0\, log_2(0) = 0$)

Exercise 10.3 **(20 P)**

Indicate the decision trees for the following boolean functions:

1. $A \wedge \neg B$ (5 P)
2. $A \vee (B \wedge C)$ (5 P)
3. (10 P)

A	B	C	f(A,B,C)
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1