T.61.5140 Machine Learning: Advanced Probablistic Methods
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Problem session, 1st of February, 2008
http://www.cis.hut.fi/Opinnot/T-61.5140/

1. Construct a causal network and follow the reasoning in the following story. Mr. Holmes is working in his office when he receives a phone call (C) from his neighbor, who tells him that Holmes' burglar alarm (A) has gone off. Convinced that a burglar has broken into his house (B), Holmes rushes to his car and heads for home. On his way, he listens to the radio, and in the news it is reported (R) that there has been a small earthquake (E) in the area. Knowing that earthquakes have a tendency to turn on burglar alarms, he returns to work.

Draw a causal network and write the joint probability for the random variables C,A,B,R,E. (pages 360-)

2. Consider the network in Figure 1. What is the Markov blanket of each variable? (pages 382-383)

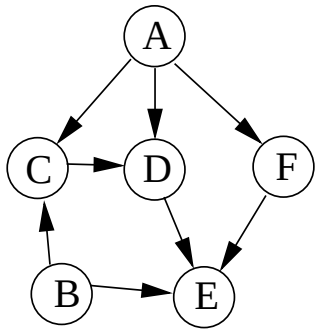

Figure 1: Problems 2 and 3.

3. From the network in Figure 1, do the following conditional independencies follow? (D-separation, page 378)
(a) $A \perp B \mid C$
(b) $A \perp B \mid \emptyset$
(c) $C \perp E \mid B, D$
(d) $C \perp D \mid A, B$
(e) $B \perp F \mid A, C$
(f) $A \perp E \mid D, F$

4. Consider the Bayesian network defined by the following tables. Write a program that generates random realisations (samples) of the variables A, B, C, D. Based on 1000 samples, estimate $P(B = 1 \mid D = 1)$.

P(A)	
A=0	0.5
A=1	0.5

P(B)	
B=0	0.8
B=1	0.2

$P(C \mid A, B)$	A=0, B=0	A=0, B=1	A=1, B=0	A=1, B=1
C=0	0.8	0.7	0.6	0.3
C=1	0.2	0.3	0.4	0.7

$P(D \mid C)$	C=0	C=1
D=0	0.9	0.2
D=1	0.1	0.8