10.1 Directed Acyclic Graphs and Graphical Models

a)
- directed acyclic graphs consist of nodes which represent random variables and directed links representing the relationships between those random variables
- links reach from one node, called *parent*, to another node, the *child* which is statistically dependent of its parents (with probability distribution $P(x_i \mid \text{parents}(x_i))$)

b)
- conditional independence means that two or more random variables are statistically independent, iff another event becomes true
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c)
- there are several possibilities, e.g. the following: F, E, B, A, D, H, C, G

d)
- factorisation: $P(X) = P(E)\,P(F)\,P(B)\,P(A|F)\,P(D|F,E,A)\,P(H|B,A)\,P(C|F,H)\,P(G|A,H)$

e)
- the Markov blanket consists of all parents, children and children's parents: F, H, D, G, E, B

f)
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$$P(B = t) = 0.01 \tag{1}$$
$$P(B = t|A = t, E = t) = \tag{2}$$

10.3 Construction of a DAG

a)
- the figure below shows a DAG based on the given random variables
- the event *Alarm* can be caused by *Burglary* and *Earthquake* while the event *Radio broadcast* can only be triggered by *Earthquake*

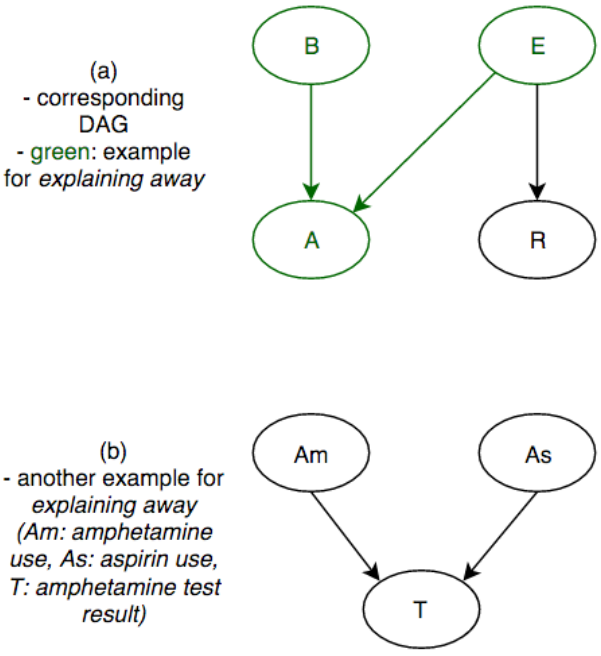

Figure 1: DAG realisation of given random variables

b)
- explaining away means that two conditionally independent random variables become conditionally dependent by observing a common child

- in the DAG above, the events *Burglary* and *Earthquake* become conditionally dependent by observing *Alarm*, e.g. if *Earthquake* and *Alarm* both become true, the probability of *Burglary* is lower than originally, because the alarm might be caused by the earthquake
- another example for *explaining away* is the situation of a quick test for amphetamine use: we asume the usage of amphetamine (Am) and the usage of aspirin (As) to be statistically independent but we know that both substances can cause a positive test result (T). If a person took aspirin ($As = t$), a positive test result ($T = t$) might be caused by this substance with a high probability which makes it unreasonable to believe that the tested person took illegal amphetamine derivates.