T-79.5102 **Autumn 2006**
Special Course in Computational Logic
Tutorial 4

1. Investigate the complexity of exact inference in general Bayesian networks.

Prove that any instance of the 3-SAT problem

Is the given set of 3-literal clauses C satisfiable?

can be reduced to exact inference in a Bayesian network $N(C)$ constructed to represent the particular problem instance C.

This indicates that exact inference in Bayesian networks in NP-hard.

(R&N, Exercise 14.8.a)

2. Consider the problem of generating a random sample from a specified distribution on a single variable. You can assume that a random number generator available that returns a random number uniformly distributed between 0 and 1.

(a) Let X be a discrete variable with $P(X = x_i) = p_i$ for $i \in \{1, ..., k\}$. The **cumulative distribution** of X gives the probability that $X \in \{x_1, \ldots, x_j\}$ for each possible j. Explain how to calculate the cumulative distribution in $O(k)$ time and how to generate a single sample of X from it.

Can the latter be done in less than $O(k)$ time?

(b) Now suppose that we want to generate N samples of X where $N \gg k$. Explain how to do this with an expected runtime per sample that is *constant* (i.e., independent of k).

(R&N, Exercise 14.9.ab)