

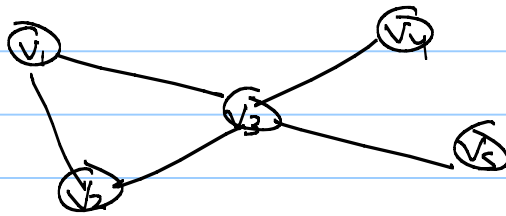
Lecture 5

Note Title

9/27/2005

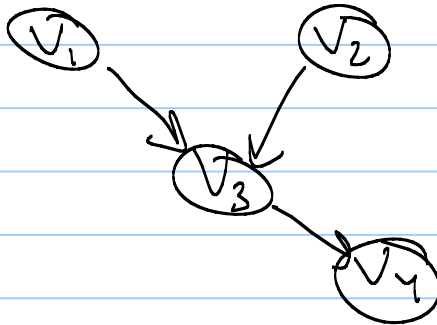
- Independence relations
- Sampling techniques

Independence in Markov Network



- Probabilistic dependencies arise when there is a path between two variables
- Conditional independence arises when there is a path connecting two variables without any nodes on the path in evidence
ex: V_1 & V_4 are conditionally independent given V_3

Independence in Bayesian networks



Is V_1 independent of V_2 ? Yes
Is V_1 independent of V_4 ? No

Two variables V_i & V_k are independent when there are no open path

An undirected path is blocked (not open) when

1. $V_i \dots \rightarrow V_j \rightarrow \dots V_k$

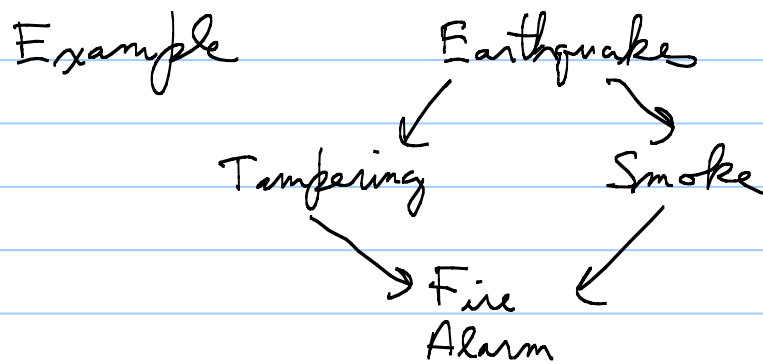
V_j is in evidence

2. $V_i \dots \leftarrow V_j \rightarrow \dots V_k$

V_j is in evidence

3. $V_i \dots \rightarrow V_j \leftarrow \dots V_k$

V_j is not in evidence
nor any of its descendants



Earthquakes & Fire alarm are dependent according to rule #1

Tampering & Smoke are independent given Earthquake according to rules #2 & 3

Markov Blanket:

Markov Blanket (V): set of variables such that if they are in evidence, all other variables are independent of V .

In a Markov network: the Markov blanket of V is all its neighbors

In a Bayesian Network: the Markov blanket of V is the parents of V , the children of V and the parents of the children of V .

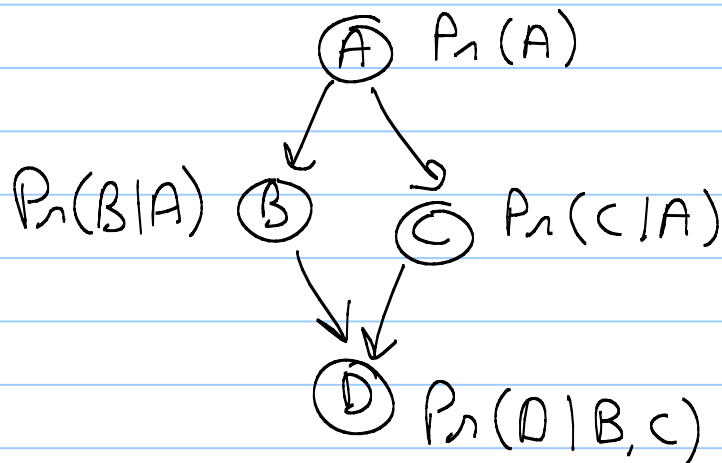
Approximation algorithms for graphical models:

- sampling
- loopy belief propagation
(with sum-product algorithm)
- variational techniques

Sampling algorithms

- Direct sampling
- Rejection sampling
- Likelihood weighting
- Importance sampling
- Markov chain Monte Carlo (MCMC)

Direct sampling:



- $P_1(D)$?
- Sample a value for A from $P(A)$
 - Sample a value for B from $P(B|A)$
 - Sample a value for C from $P(C|A)$
 - Sample a value for D from $P(D|B,C)$

Rejection sampling:

$$Pr(C | D=x)?$$

Do direct sampling but reject all samples that are inconsistent with the evidence.

In practice most samples rejected since probability that a sample is inconsistent grows exponentially with the number of vars in evidence