UNIT 01 – INTRODUCING BAYESIAN NETWORKS

A MURDER CASE !!!

A young girl, Lulu, has been found murdered at her home with many knife wounds. The knife has not been found. Some bloodstains have been recovered on the scene of the crime which do not share Lulu's DNA profile. A friend of hers, Jack, has been seen near Lulu's house around the time of the murder by John. There is some evidence that Jack was badly in love with Lulu. Though It is not known for certain, Instead, it is a hypothesis based on information which is not totally reliable and a hypothesis that can furnish an alternative explanation of Jack's presence near Lulu's house. John has stated that he also was interested In Lulu. A blood sample has been taken from Jack. It is also assumed that the fact that John himself fell in love with Lulu can prejudice his reliability as a witness.

Taroni, F., Aitken, C., Garbolino, P., & Biedermann, A. (2006). *Bayesian Networks and Probabilistic Inference in Forensic Science* (1 edition). Chichester, England ; Hoboken, NJ: Wiley.

A MURDER CASE – RANDOM VARIABLES

A:	Jack stabbed Lulu.
B:	Bloodstain at crime scene comes from offender.
C:	Bloodstain at crime scene comes from Jack.
E:	Jack's blood sample and crime stain share the same DNA profile.
F:	Jack was in a certain place f near the house where Lulu lived shortly after the time the crime was committed.
W:	John says that Jack was in place f shortly after the time when the crime was committed.
J:	Jack loved Lulu.
D:	John was jealous of Jack.

A MURDER CASE – MODEL

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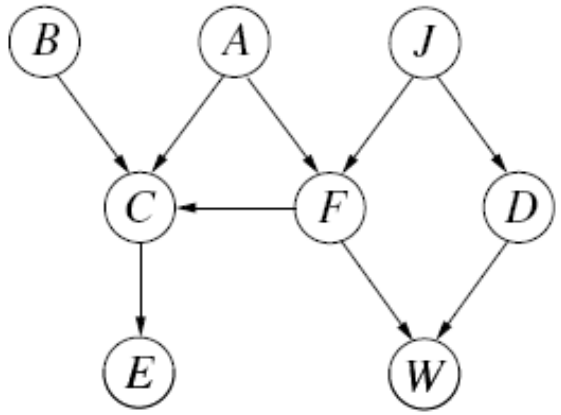


UNCERTAINTIES INVOLVED

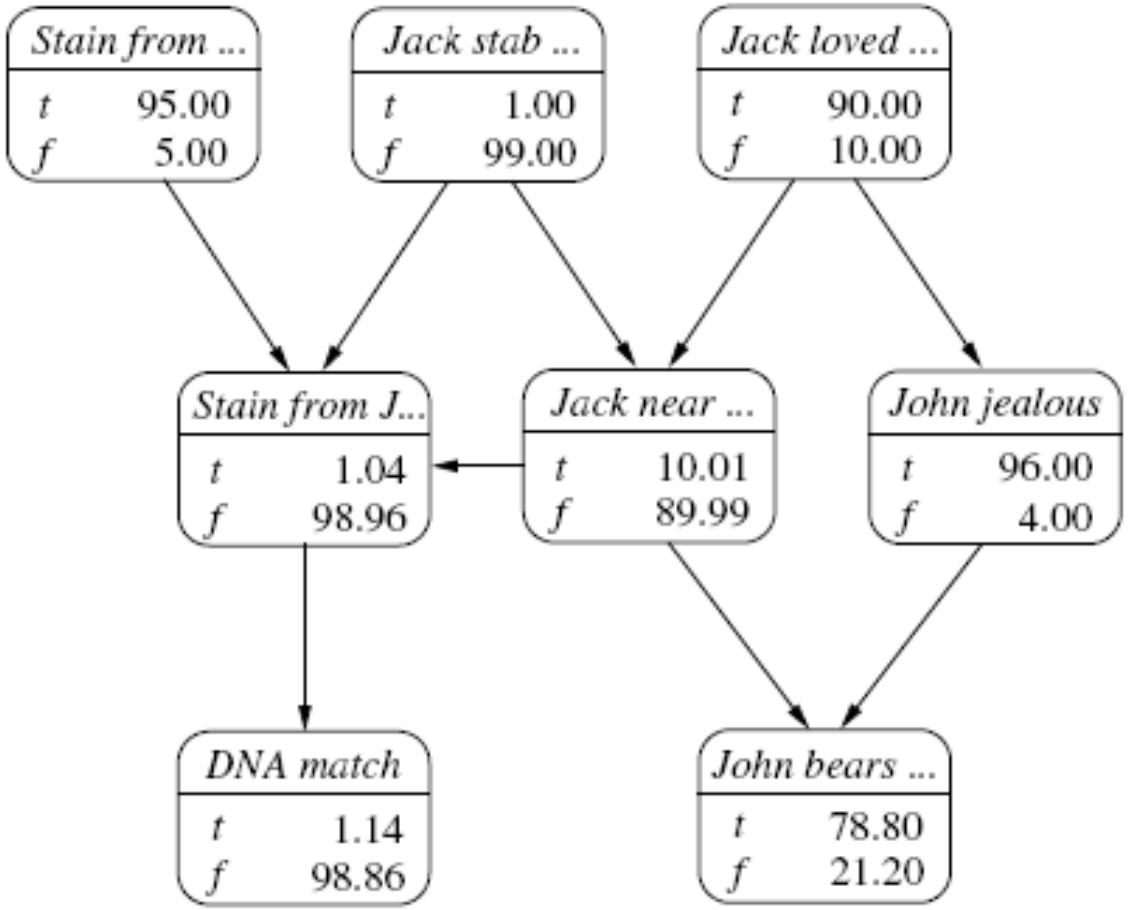
Jack may or may not be the offender.

Crime stain may or may not be relevant to the case.

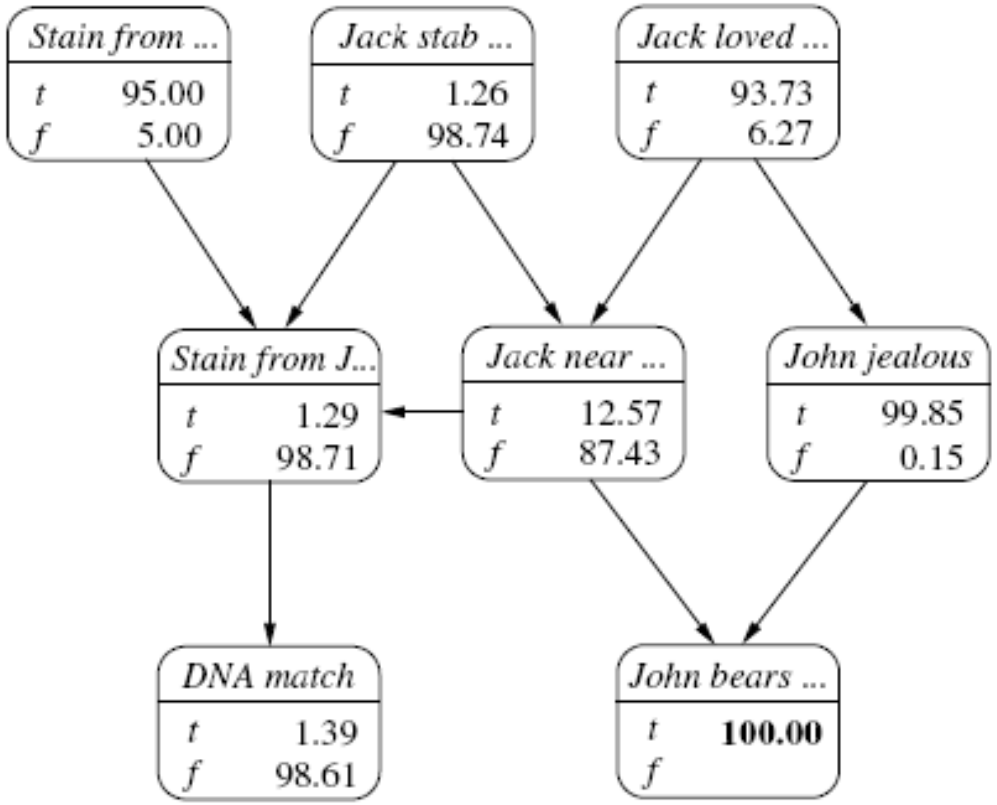
Jack may or may not be in love with Lulu.

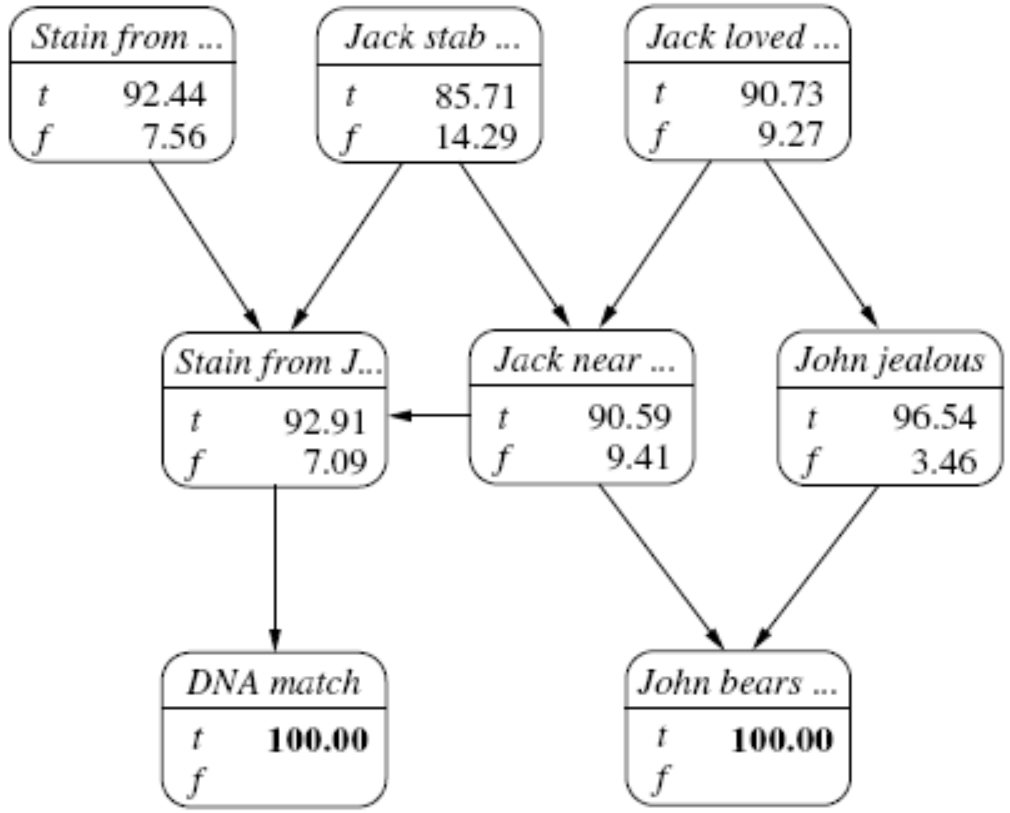
John may or may not be prejudiced against Jack.

MARGINAL PROBABILITIES



SETTING EVIDENCES





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BAYESIAN NETWORKS

Bayesian Networks are a technique for describing complex joint distributions using a bunch of simple, local distributions.

- We describe how variables locally interact
- Local interactions chain together to give global, indirect interactions

PARAMETERS OF A BN

A problem domain is modeled by a list of variables $X_1, X_2, \ldots, X_n$.

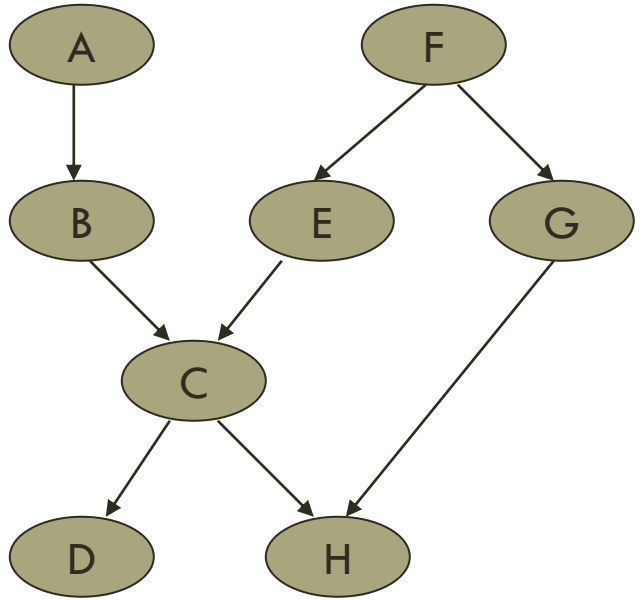
Knowledge about the problem domain is represented by a joint probability $P(X_1, X_2, \ldots, X_n)$.

General probability distribution of 8 variables with 2 states each has $2^8 = 256$ possible values and $2^8 - 1$ probabilities need to be specified.

Assumes that each node is conditionally independent of all its non-descendants given its parents.

Product of all conditional probabilities is the joint probability of all variables.

- $P(X_1, X_2, \ldots, X_n) = \prod P(X_i \mid \text{parents}(X_i))$



18 probabilities are required to specify the joint distribution

EARTHQUAKE EXAMPLE

You have a new burglar alarm installed.

It is reliable about detecting burglary and earthquakes.

Two neighbors (John, Mary) promises to call you at work when they hear the alarm.

Given evidence about who has and hasn't called, Assess the possibility of a burglary/earthquake.

EARTHQUAKE EXAMPLE (PEARL)

You have a new burglar alarm installed.

It is reliable about detecting burglary, but does not respond to minor earthquakes.

Two neighbors (John, Mary) promises to call you at work when they hear the alarm.

- John always call when hears alarm, but confuses alarm with phone ringing (and calls then also)
- Mary likes loud music and sometimes misses alarm

Given evidence about who has and hasn't called, estimate the probability of a burglary.

CAUSE AND EFFECT RELATIONSHIPS

Burglary → Alarm Goes Off

Earthquake → Alarm Goes Off

Alarm Goes Off → John Calls

Alarm Goes Off → Mary Calls

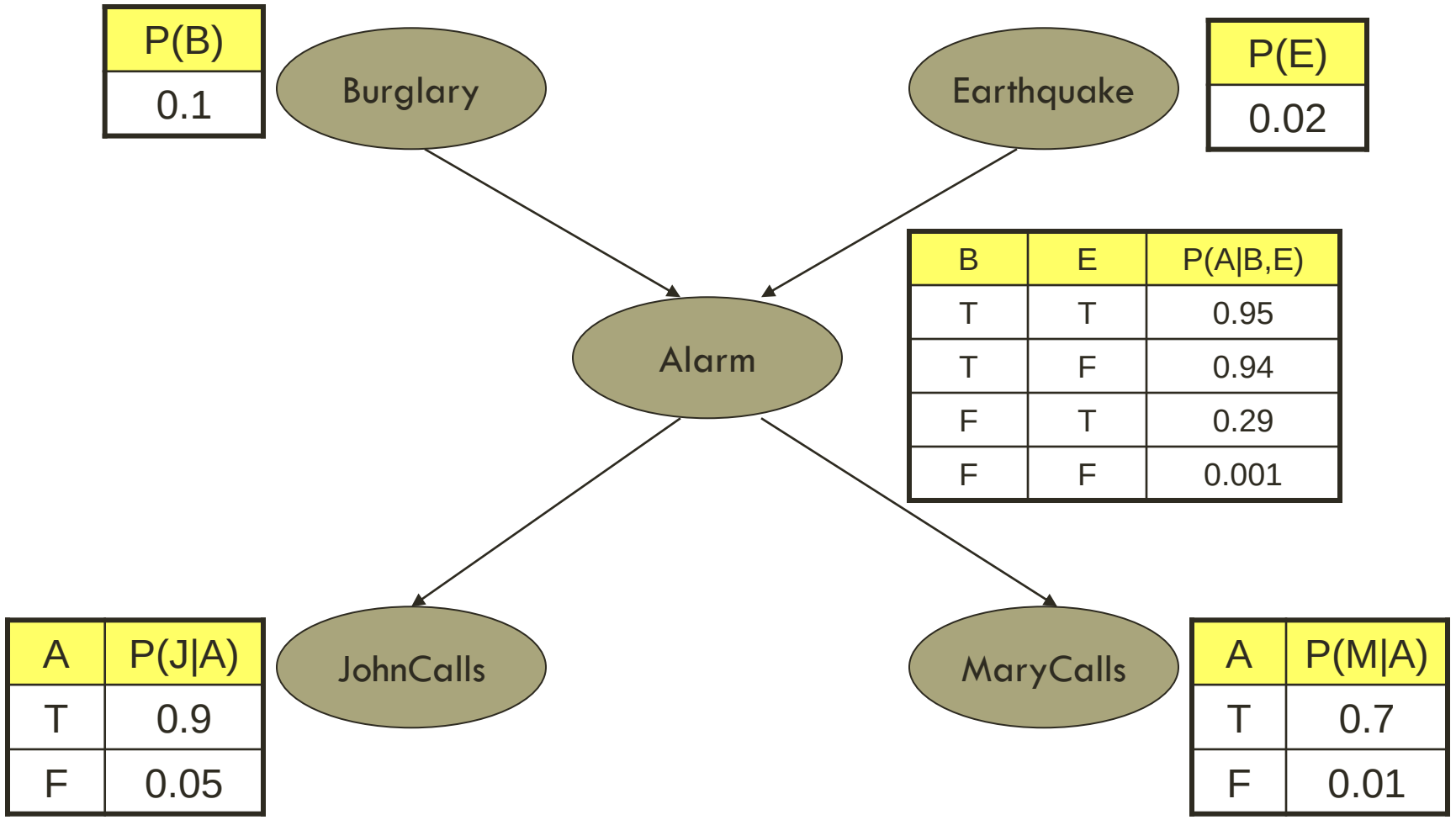
Number of Variables

- 5

Number of Links

- 4

Earthquake Example (Pearl)



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