

Probabilistic Reasoning

Bayesian Network

Bayesian network

independence and conditional independence relationships in simplifying probabilistic representations of the world using **Bayesian networks**

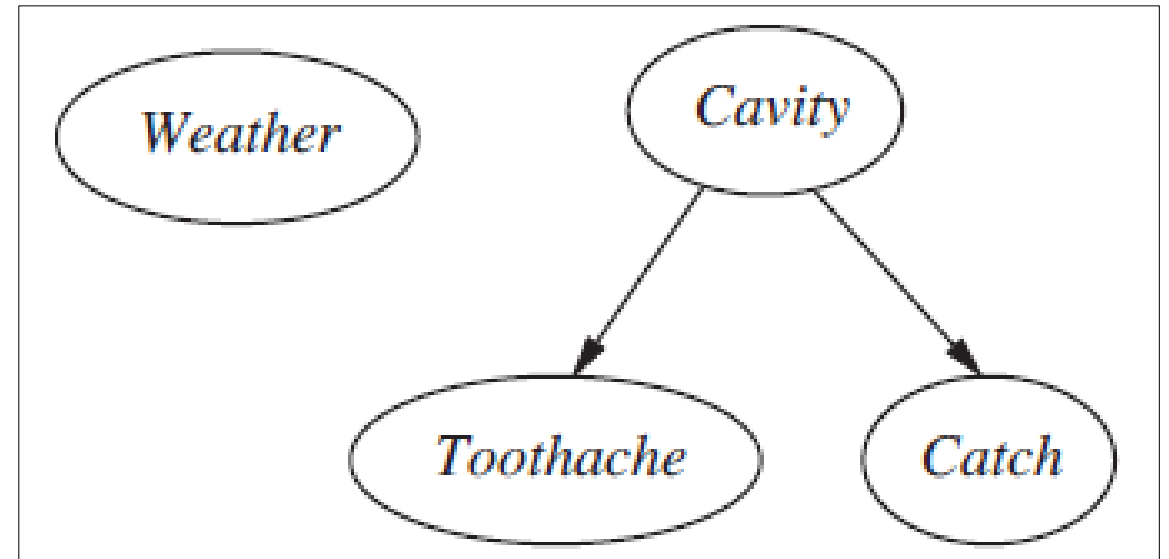
A Bayesian network is a **directed graph** in which each node is annotated with quantitative probability information.

The full specification is as follows:

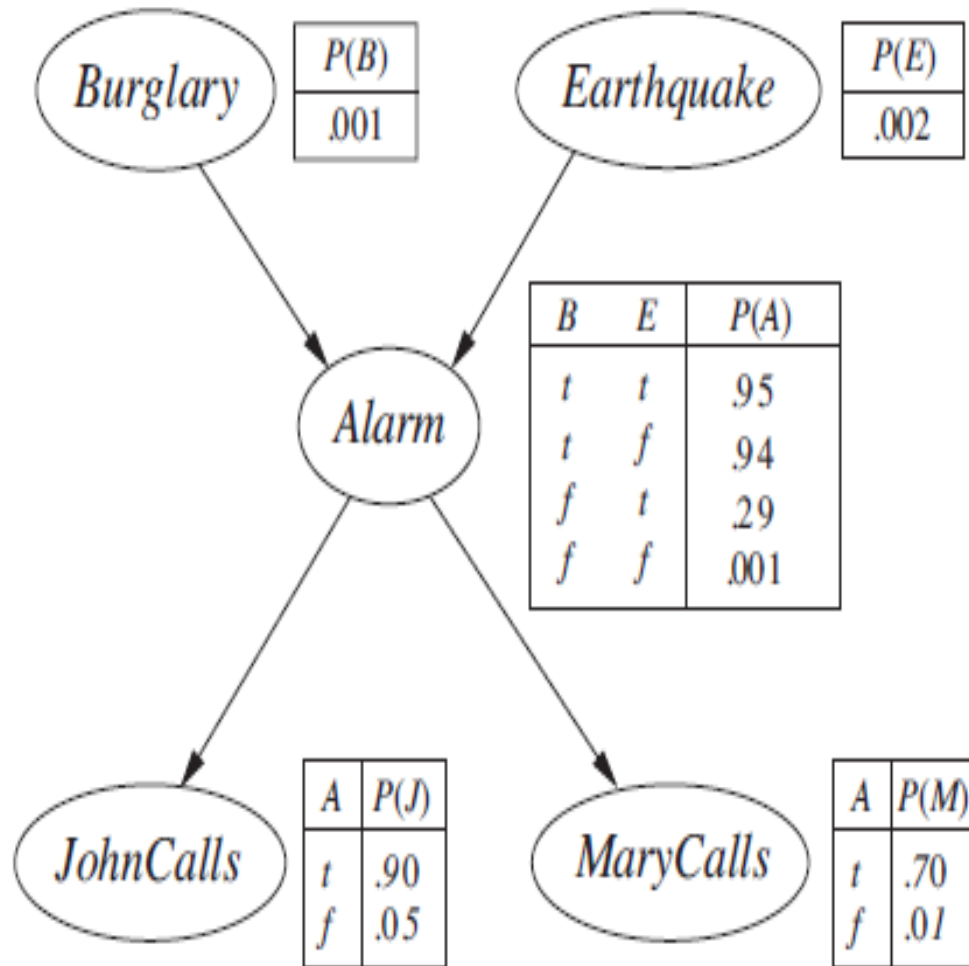
1. Each **node** corresponds to a **random variable**, which may be discrete or continuous.
2. A set of directed **links or arrows** connects pairs of nodes. If there is an arrow from node X to node Y, X is said to be a **parent** of Y. The graph has no directed cycles (and hence is a directed acyclic graph, or DAG).
3. Each node X_i has a **conditional probability distribution** $P(X_i | \text{Parents}(X_i))$ that quantifies the effect of the parents on the node.

Bayesian network...

- consisting of the variables *Toothache*, *Cavity*, *Catch*, and *Weather*
- *Weather* is independent of the other variables;
- *Toothache* and *Catch* are conditionally independent, given *Cavity*.



Bayesian network...



Burglar alarm

- Detecting a burglary, also responds to minor earthquakes.
- Two neighbors, John and Mary, promised to on hearing alarm.
- John sometimes confuses the telephone ringing
- Mary, loud music and often misses the alarm altogether.
- Estimate the probability of a burglary.
- Burglary and earthquakes directly affect the probability of alarm's going off, but whether john and mary call depends only on the alarm.

Bayesian network...

- The conditional distributions shown as a conditional probability table, or CPT.
- Each row in a CPT contains the conditional probability of each node value for a conditioning case.
- A conditioning case is just a possible combination of values for the parent nodes—a miniature possible world, if you like. Each row must sum to 1, because the entries represent an exhaustive set of cases for the variable.
- For Boolean variables, once you know that the probability of a true value is p , the probability of false must be $1 - p$, so we often omit the second number.
- A table for a Boolean variable with k Boolean parents contains 2^k independently specifiable probabilities.
- A node with no parents has only one row, representing the prior probabilities of each possible value of the variable.

Making simple decisions

