Bayesian Networks in more detail

* Imagine trying to model a situation in which causality plays a role but where our understanding is incomplete.

\[ \Rightarrow \text{We need to describe things probabilistically} \]

Example:

* Suppose I want to know if my family is home before I try the doors.
* Often when my wife leaves the house, she turns on an outdoor light.
* She also turns on this light when she is expecting a guest.
* When nobody is home, the dog is put outside.
* But the dog is also put out when it has bowel problems.
* If dog is outside, I will probably hear it barking.
* But sometimes it is another dog that I hear.
Light is out?

What if I hear the dog bark the dog.

The light is on, but I do not hear.

Should I assume the family is out?

Example is that sentences are not absolutes.

Note: What is important about our

Connections

* Aces can be interpreted as casual

* Leaders denote states of affairs.

Here - bark

Dog - out

Light - on

Problem - move

Problem - out

be used to describe this situation.

Here is a

edges between your network.
We will assume discrete values.

Booleans

Continuous, categorical, etc.

Random variables can be

Nodes are random variables

Random processes are vectors

Some details

Directed Acyclic Graph (DAG)

Neighbor sets

Probabilities, log-odds, relative odds

Calculate them from a small set of

Bayesian networks allows us to

For all combinations

These probabilities are not usually

we would be set

such as P(sunny | light rain). Then:

If we know the relevant probabilities,
The arcs in the network specify independence. To specify a Bayesian network, we must give the prior probabilities of all root nodes. Given the direct predecessors of all possible combinations of nonroot nodes, the conditional probabilities of the fully specified Bayesian network are specified.
Before we go further, we need to talk about independence assumption. In a Bayesian network, this assumption is challenging, but this is also a probabilistic belief of the nodes and it is common to think that the probablities of the nodes are 100% of the nodes. A Bayesian network allows you to calculate the conditional probabilities of some nodes given that the value of the nodes. This is called evidential reasoning.
A: 10. It's my family who baked it. Intuitively, independent.

Are the random variables family-wise or a

assumption?

Example:

Answer: Burt - in independence

Come from?

Where does this causation

Yet, we only specified the

our example would be when

The complete distribution for

n is the # of variables

A joint probability table, whence

a equals discretion is

that the complete specification

Independence Assumptions
P(a | b E) ≠ P(a | E)

Note: P(a | b E) = P(a) but a is independent of b given E.

If a is not dependent on b given E, include a on b.

E among the evidence nodes. I can not path from a to b given E.

E = 2, ..., 7

If there is a D-connected
is dependent on a condition b given evidence

In a Bayesian network, a variable a

We need to formalize this observation

This is beauty of Bayesian

\[
P(\text{a is independent?}) \neq \frac{P(\text{a is independent?}) \times P(\text{a is independent?})}{P(\text{a is independent?})}
\]

In that case and family-out, dog-out.

P(hear - bark | family-out, dog-out)

P(hear - bark | dog-out)

\[
P(\text{a is independent?}) \neq \frac{P(\text{a is independent?}) \times P(\text{a is independent?})}{P(\text{a is independent?})}
\]
Definition of $d$-connecting

A path from $a$ to $b$ is $d$-connecting with respect to the evidence nodes $E$ if every interior node $n$ has the property that either it is linear or one of its descendent is in $E$. It is linear or diverging and not a $d$-connecting $a$ to $b$ to $c$ neighbor.

Consider the variables $a$, $b$, and $c$. We need to know what about our exam? We need to.
are independent.

Connection, then the two things are not connected. Some states of things can cause
something further.

something else. Once we know about a middle node, we do not need to know about
internal nodes. The same applies to no connection.

Rout. (1) in more detail.

Nodes connected with each other (2).

There is evidence that reduces the two
is a causal path between them (1). In
Two nodes are not connected if evidence that
Hence.

as well.

In the literature, you'll see discrepancies.
There is a disconnecting path.  

There is likely a disconnecting path.  

Likely explanations become more less.  

Likely explanations become more less.  

Because we eliminated the

Keep has bowel problems.  

Does it arise possibility that the  

Is there should slightly  

Example, knowing the family  

There was no evidence. For  

Independent? No, even though  

Family - cancer and bowel problems

Is member of E. He was once  

Does it out. That is does not

Suppose we know that the

(Part 2) In more detail: