**Bayesian Networks**

Might just call Conditional Networks – don’t see Baye’s law in here per se´.

Might go back and review Event Composition file in Prob+Stat folder. Recall that the joint probability distribution could be written in terms of conditional probabilities, so that if one knew the latter, one could get the former. Such conditional probability networks are called Bayesian networks. Consider the following network, on the below.

Diagram

Description automatically generated

The presence of Clouds affects the presence of Sprinkler (being on), and the presence of Rain (happening). And both affect the presence of Grass being wet. The arrows give us the directions of the causal relationships. It suffices, for calculating certain (all?) probabilities, to write down the conditional probability table for each node, i.e., the probability of that node given any of the events that cause it. So we’d have: P(C), P(S|C), P(R|C), P(G|S,R). Also note that we only need the conditional probability of G w/r to its direct causal antecedents. This is because Bayesian networks satisfy the Local Markov property.

**Local Markov property**: *the* *probability of node is conditionally independent of its non-descendents, given its parent(s) (i.e.direct antecedant(s)).*

For instance, P(S|C,R) = P(S|C) and P(SR|C) = P(S|C)\*P(R|C). This property simplifies the joint probability distribution into an intuitive result:



We can calculate the probability P(x) of some subset of events, x, by summing our expression above over all irrelevant variables. And we can calculate conditional probabilities, P(x|e), via P(xe)/P(e) and using the expression above to calculate the numerator and denominator. Say for instance,



**Example**

Let’s do example. What is P(S)? Well one way is to say:



where True is on top, and False is on bottom. Taken together with next example, I guess to get the probability of an event you use the event composition rule for the event and all of its antecedents.

**Example**

What is P(G)?



Now filling in the numbers,

