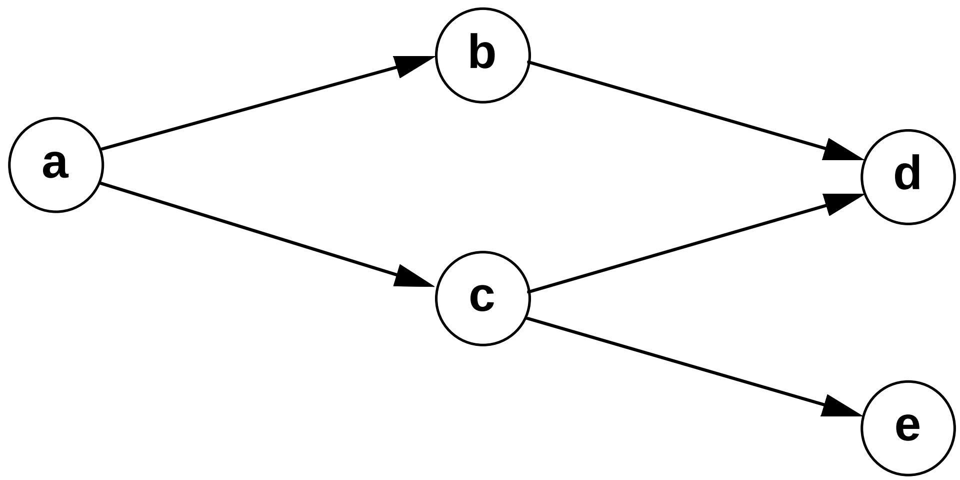
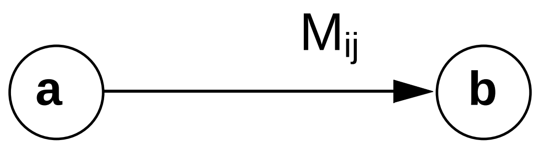
A Bayesian Network



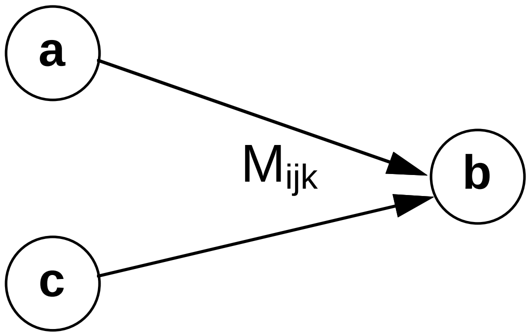
Pr(a,b,c,d,e) = Pr(a) Pr(b|a) Pr(c|a,b) Pr(d|a,b,c) Pr(e|a,b,c,d)

= Pr(a) Pr(b|a) Pr(c|a) Pr(d|b,c) Pr(e|c)

Links Encode Conditional Probabilities



M: $Pr(b = b_j \mid a = a_i)$



M: $Pr(b = b_j \mid a = a_i, c = c_k)$

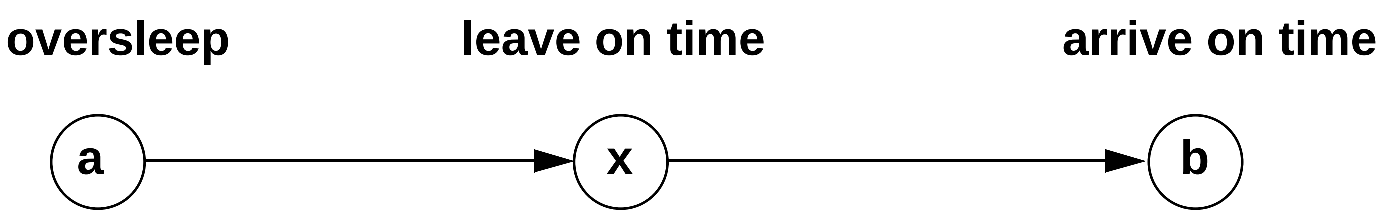
Conditional Independence

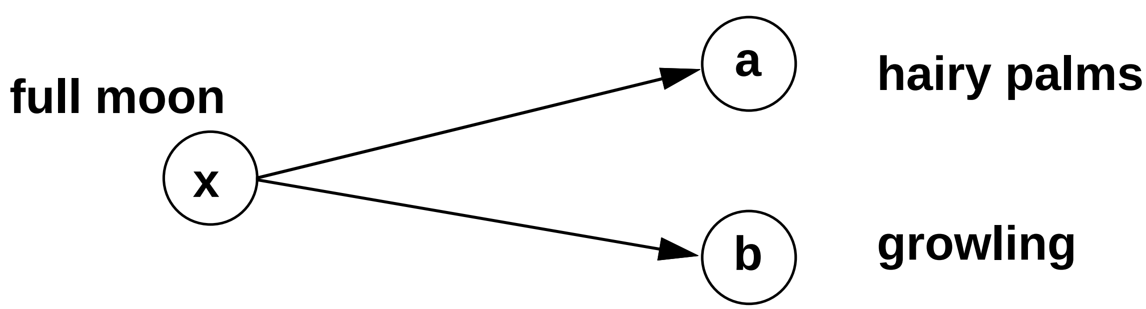
Equivalent statements:

- **b adds no useful information about a, given S**
- **Pr (a | b, s) = Pr (a | s)**
- **CI (a, S, b)**
- **CI (b, S, a)**
- **a and b "d-separated" by S in graph**

Separation in Graphs: 1, 2

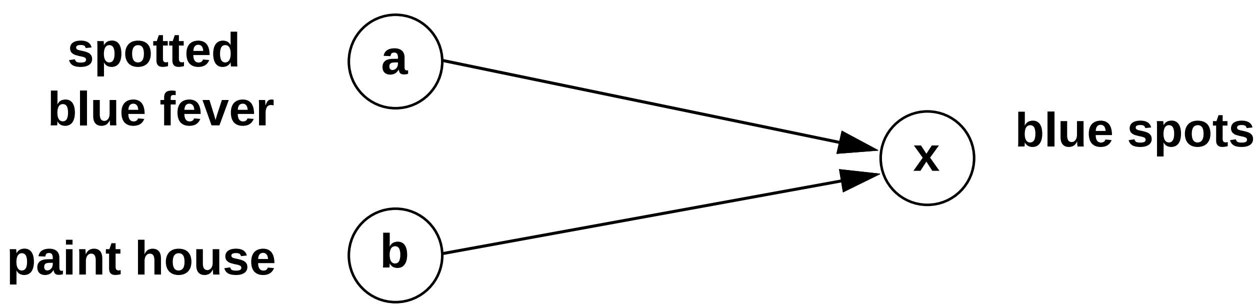
x **blocks the path from** *a* **to** *b***:**





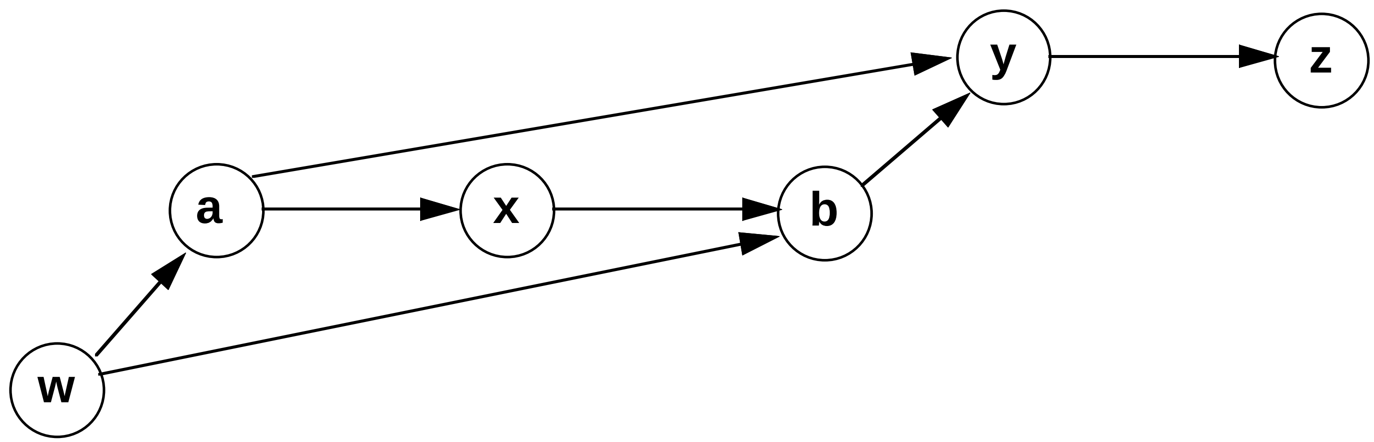
Separation in Graphs: 3

x ***un*****blocks the path from *a* to *b*:**



D-Separation

<u>Defn</u>: Variables *a* and *b* are *d-separated* by S iff every undirected path from *a* to *b* is blocked by a variable in S and no path is unblocked.

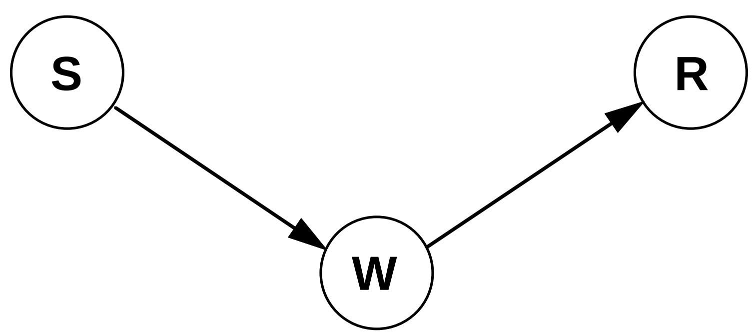


a **and** ***b*** **are** ***d-separated*** **by {** ***w, x*** **} but by no other subset of {** ***w,x,y,z*** **}**

Direction Matters

IF the sprinkler was on last night
THEN there is suggestive evidence (0.9) that the grass will be wet this morning.

IF the grass is wet this morning
THEN there is suggestive evidence (0.8) that it rained last night.



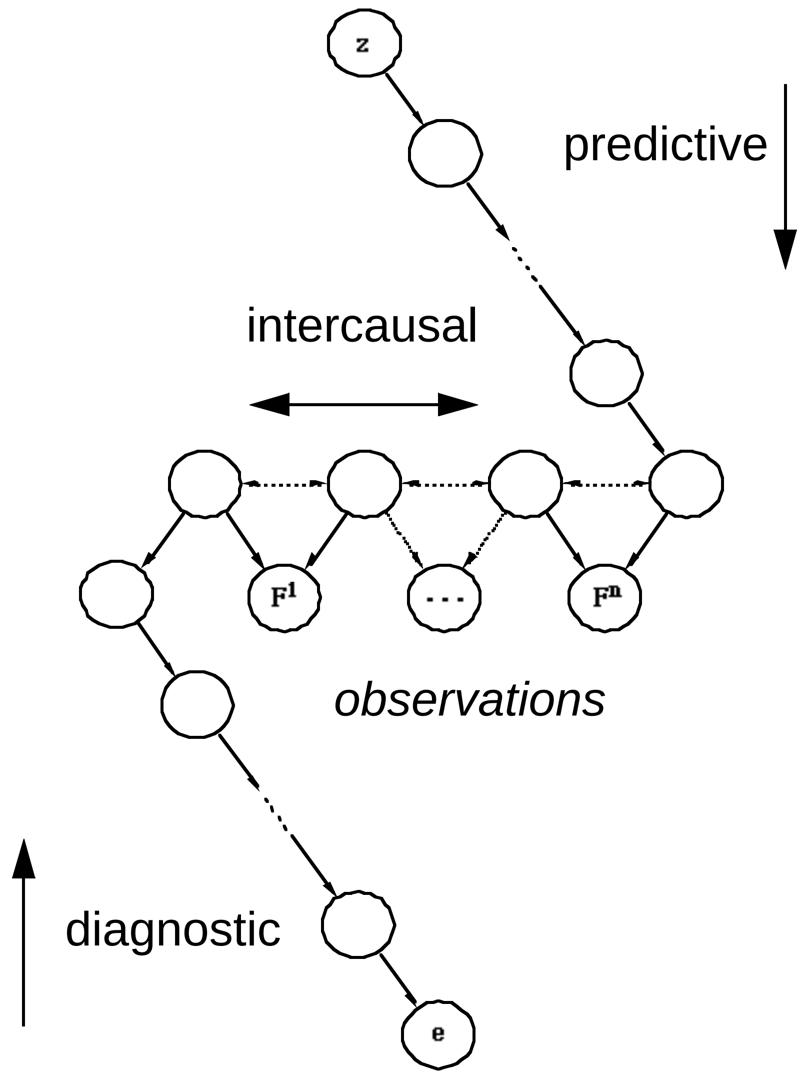
Reasoning Patterns

Asymmetry of probabilistic dependence requires distinction between *predictive* and *diagnostic* inference.

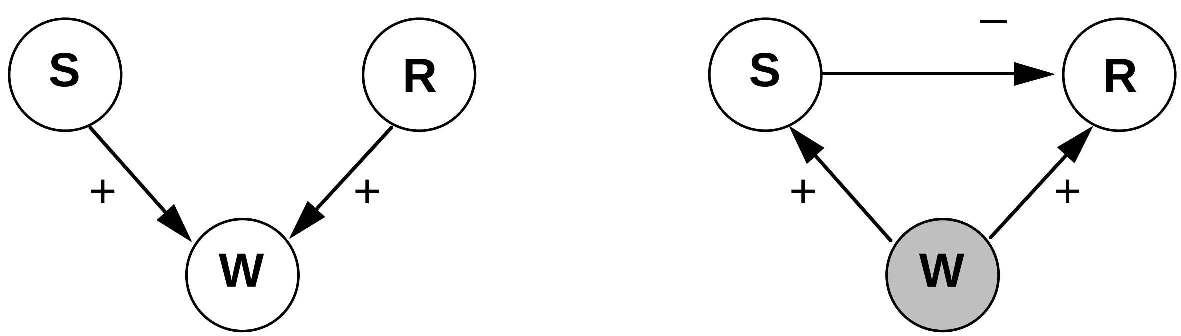
predictive = causal

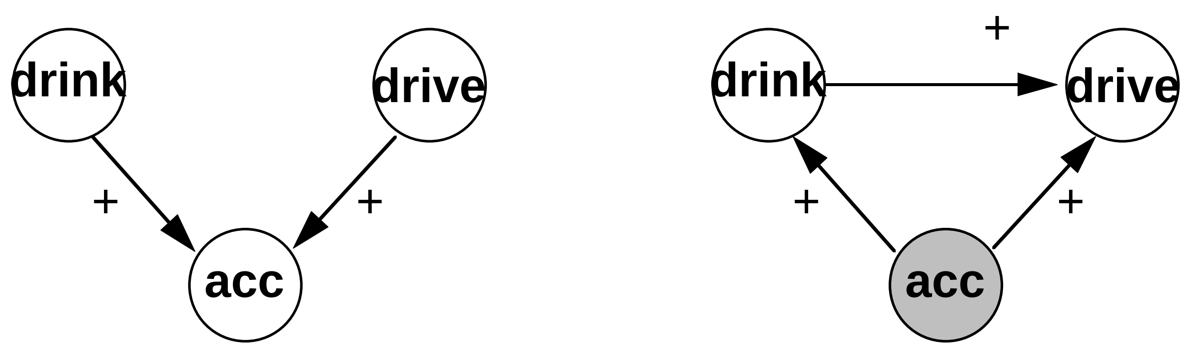
diagnostic = evidential

***Intercausal relations* specify interactions among causes of a common effect.**

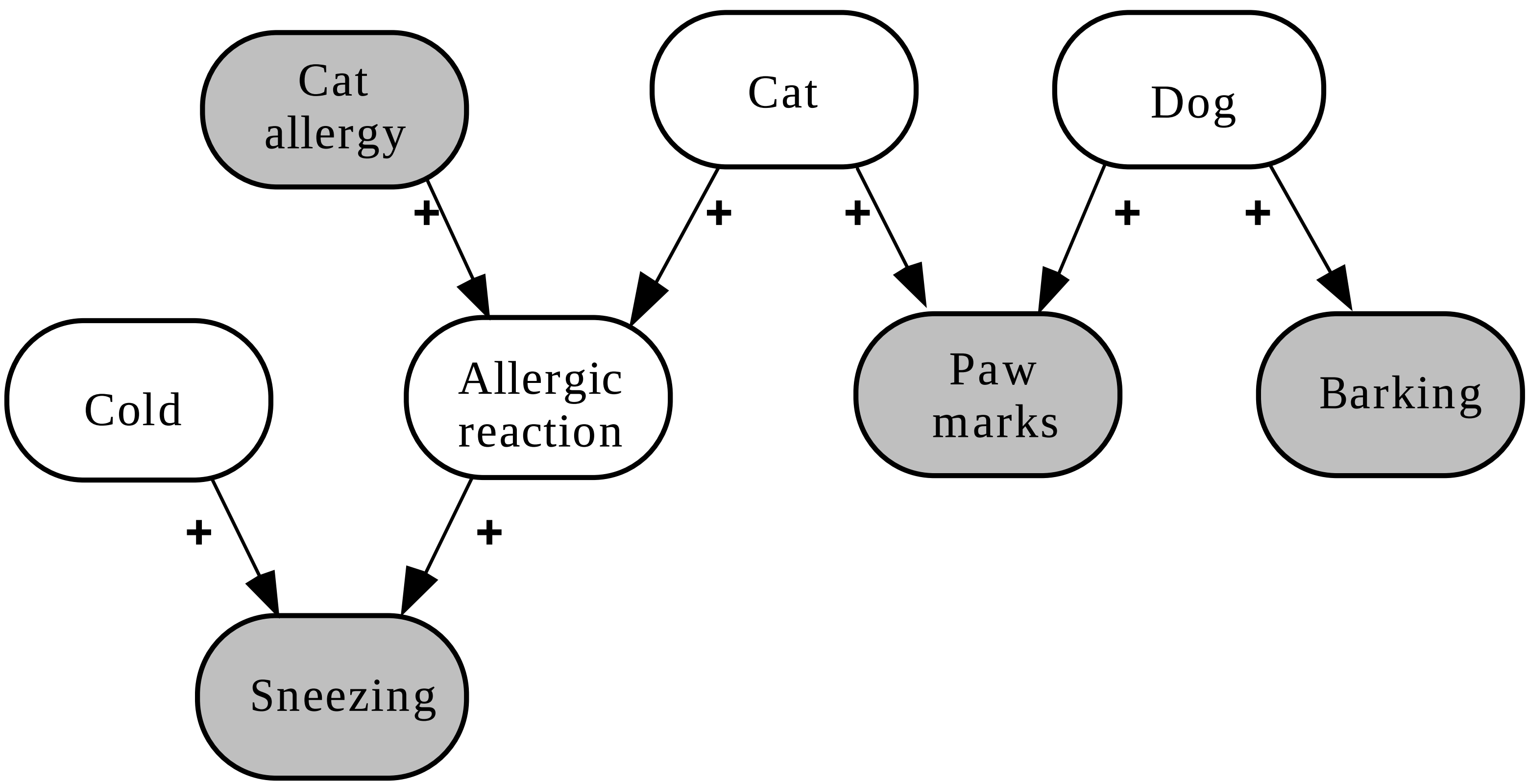


“Explaining Away”

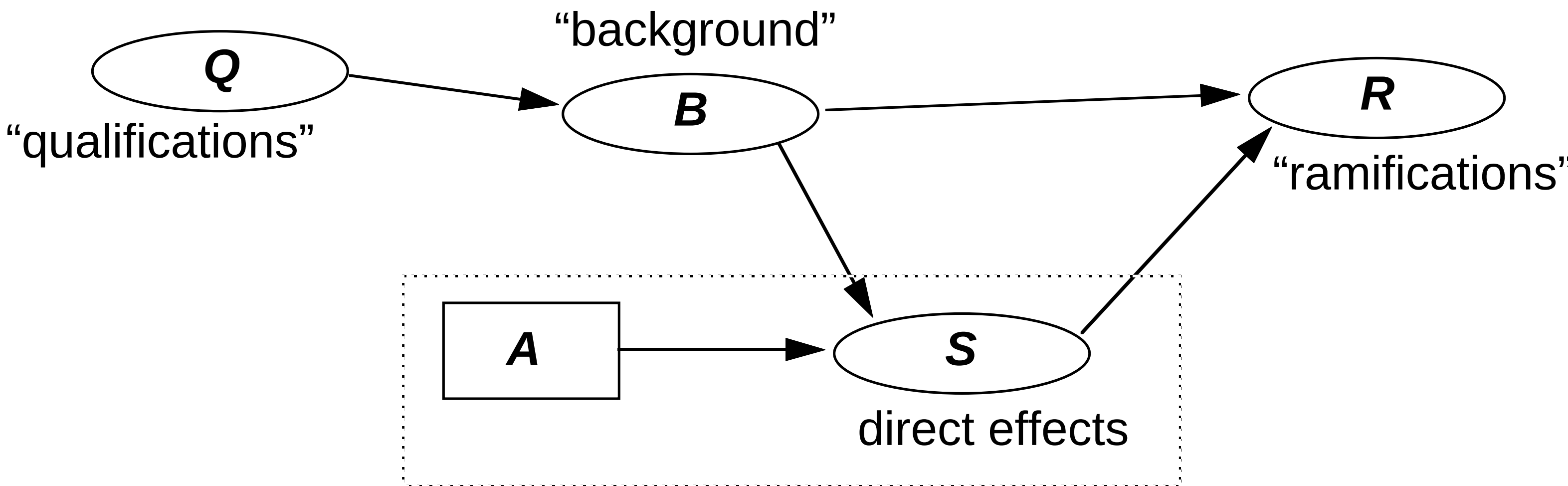




Intercausal Reasoning



Schematic Action Model



- **A is CI of both Q and R given S ∪ B.**
- **Express effect as Pr(S | A, B), often simplifiable to [S | A] using:**
  - **canonical models**
  - **ceteris paribus clause**