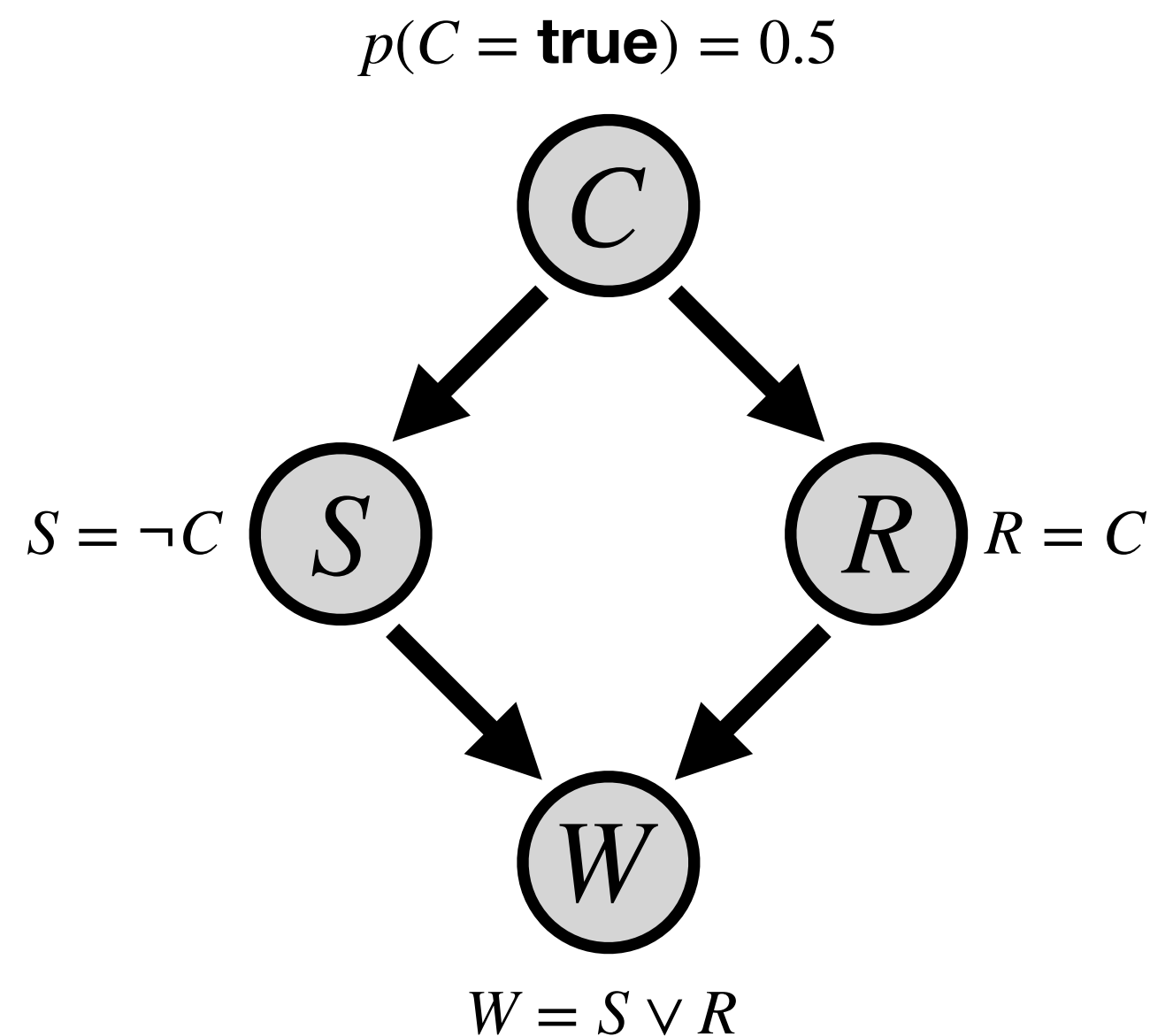
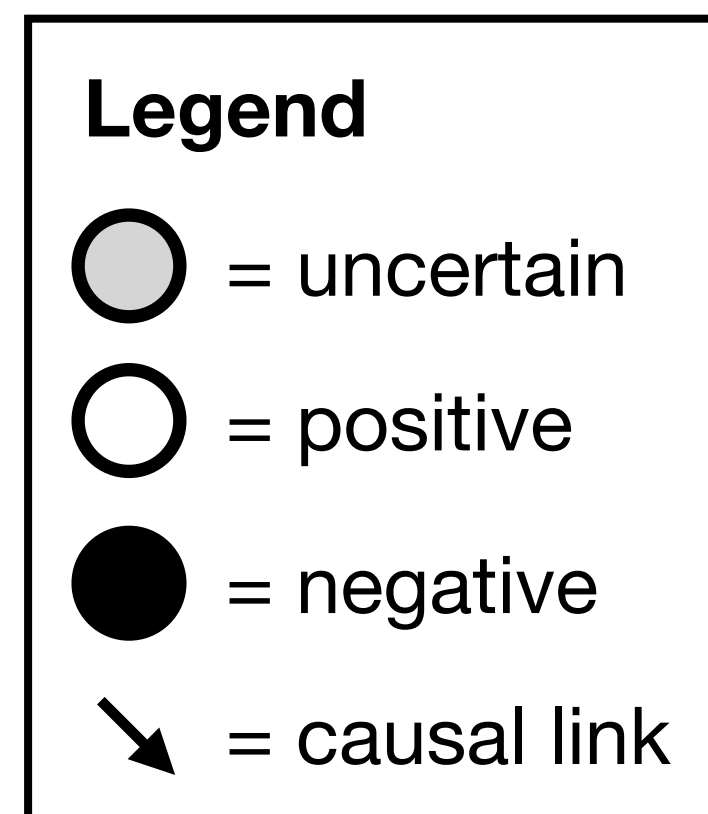
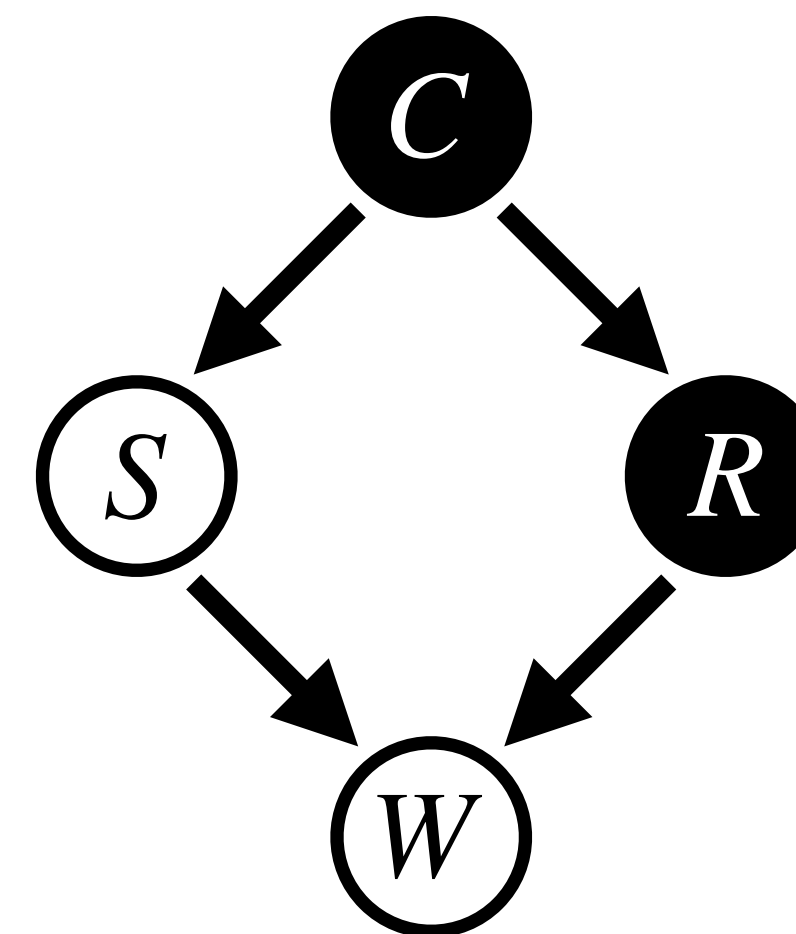


(a) causal structure



(b) what actually happened

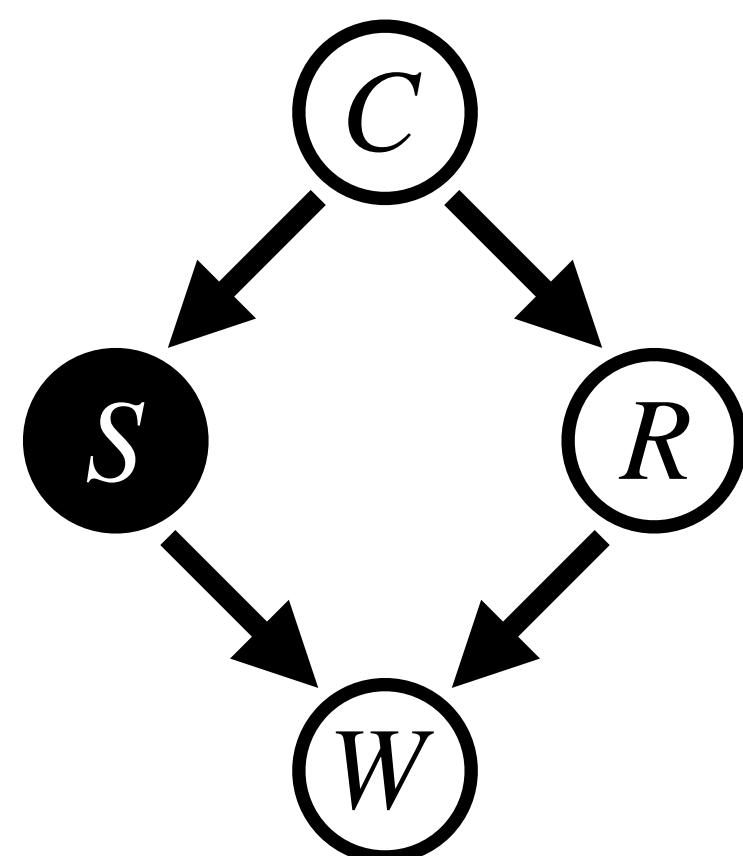


There were no **c**louds,  
it didn't **r**ain, the  
**s**prinkler was on, and  
the grass was **w**et.

Did the sprinkler cause  
the grass to be wet?

$$p(s \rightarrow w) = ?$$

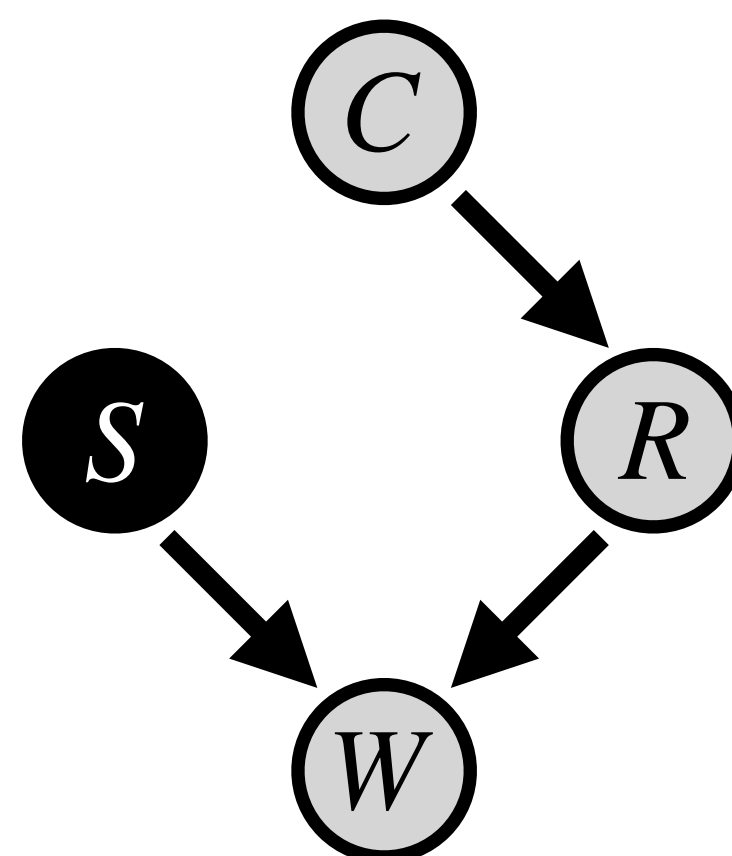
(c) observation (**level I**)



Is the grass dry when the sprinkler is off?

$$p(w' | s') = 0$$

(d) intervention (**level II**)

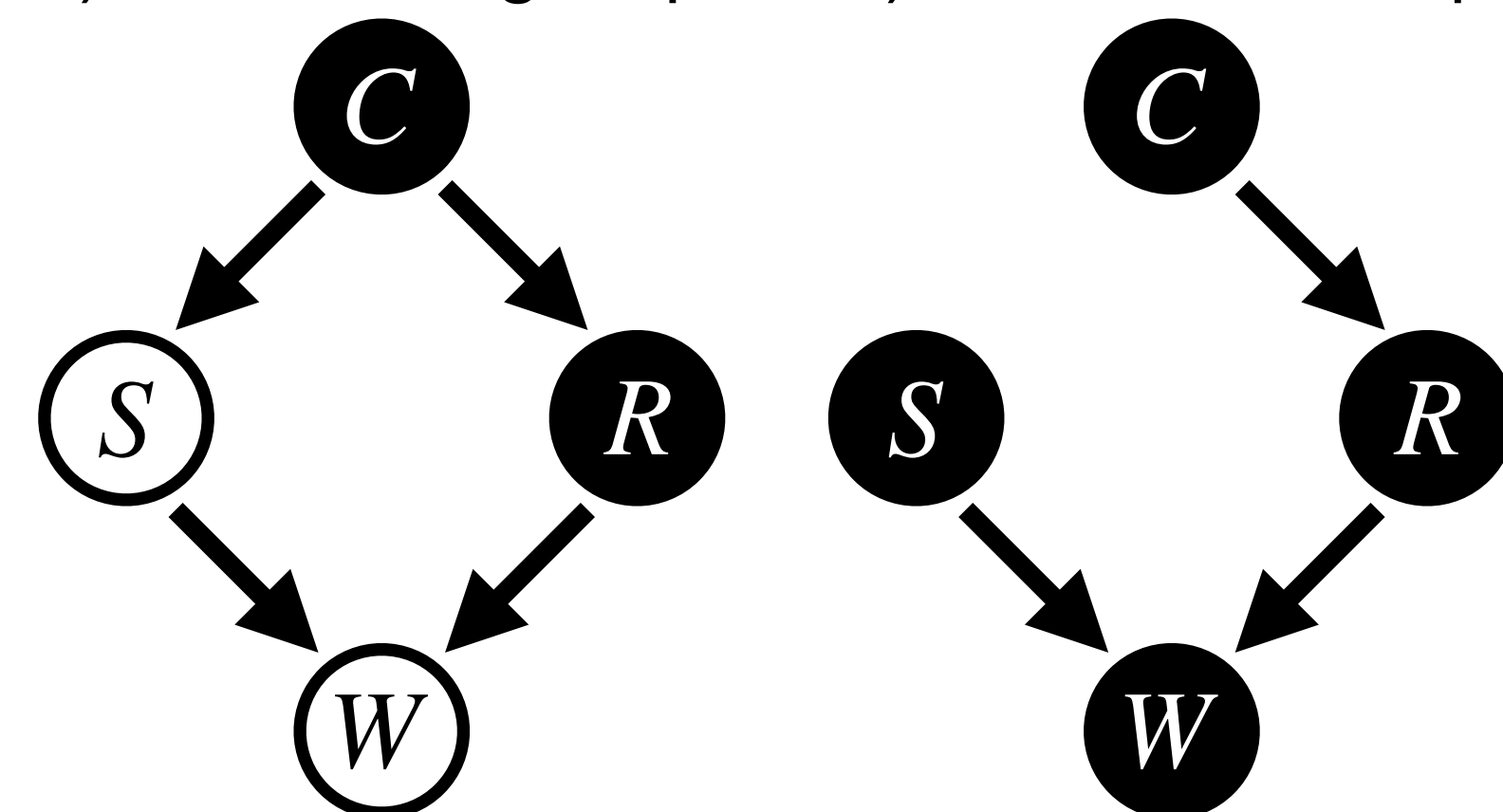


Would the grass be dry if the sprinkler was off?

$$p(w' | \mathbf{do}(s')) = 0.5$$

(e) counterfactual (**level III**)

1) conditioning step      2) intervention step



Would the grass have been dry if the  
sprinkler had been off?

$$p(w'_s | c', s, r', w) = 1$$