Bayesian Network | ML LAB 7

What is Bayesian Networks?

- A Bayesian network is a directed acyclic graph in which each edge corresponds to a conditional dependency, and each node corresponds to a unique random variable.
- Bayesian networks are a type of probabilistic graphical model that uses Bayesian inference for probability computations.

Some info on probability

For two events

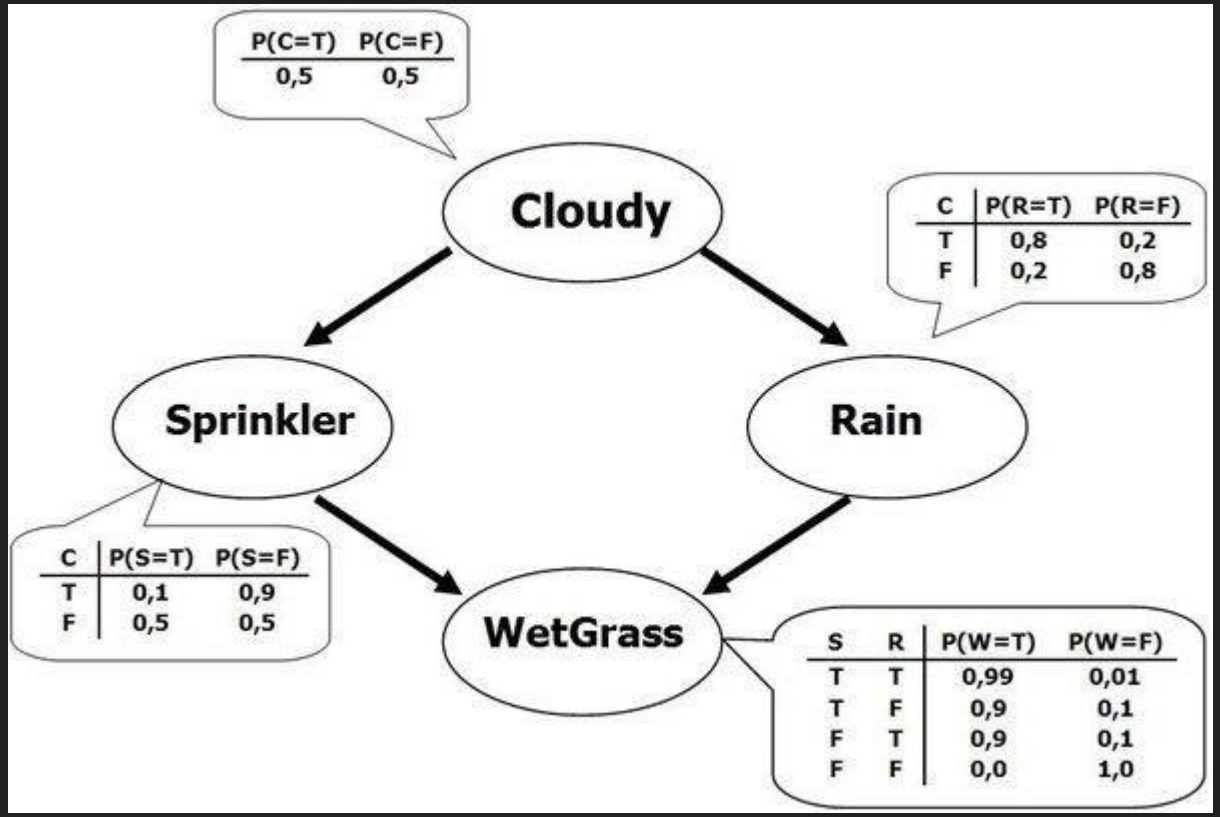
$$P(A \cap B) = P(B \mid A) \cdot P(A).$$

For N events

$$\mathrm{P}(A_n \cap \ldots \cap A_1) = \mathrm{P}(A_n | A_{n-1} \cap \ldots \cap A_1) \cdot \mathrm{P}(A_{n-1} \cap \ldots \cap A_1)$$

$$\mathrm{P}(A_n \cap \ldots \cap A_1) = \prod_{k=1}^{n} \mathrm{P}\left(A_k \,\middle|\, \bigcap_{j=1}^{k-1} A_j\right).$$

Example of Bayesian Network



If an edge (A, B) exists in the graph connecting random variables A and B, it means that P(B|A) is a factor in the joint probability distribution, so we must know P(B|A) for all values of B and A in order to conduct inference.

Lets derive the formula

- Bayesian network satisfy the local Markov property, which states that a node is conditionally independent of its non-descendants given its parents.

  P(Sprinkler|Cloudy, Rain) = P(Sprinkler|Cloudy)

- Since Sprinkler is conditionally independent of its non-descendant, Rain, given Cloudy. This property allows us to simplify the joint distribution, obtained in the previous section using the chain rule, to a smaller form.

$$P(X_1,\ldots,X_n)=\prod_{i=1}^{n}P(X_i \mid X_1,\ldots,X_{i-1})=\prod_{i=1}^{n}P(X_i \mid Parents(X_i))$$

What is Maximum likelihood and Variable Elimination

- Maximum likelihood estimation is a method of estimating the parameters of a probability distribution by maximizing a likelihood function
- Variable elimination is a simple and general exact inference algorithm in probabilistic graphical models, such as Bayesian networks and Markov random fields