SNS COLLEGE OF TECHNOLOGY
Coimbatore-35
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DEPARTMENT OF AI&ML
FOUNDATIONS OF ARTIFICIAL INTELLIGENCE
II YEAR - III SEM

TEMPORAL MODEL

Temporal Models

- Two sections in Temporal Model,
  - Time and Uncertainty
    - **States and observations**
    - **Stationary processes and the Markov assumption**
  - Inference in Temporal Model

Temporal Models - Time and Uncertainty

- A changing world is modeled using a random variable for each aspect of the environment state, *at each point in time.*
- The relations among these variables describe how the state evolves.

Temporal Models

- Agents in uncertain environments must be able to keep track of the current state of the environment, just as logical agents must.
- This is difficult by partial and noisy data, because the environment is uncertain over time.
- At best, the agent will be able to obtain only a probabilistic assessment of the current situation.

Example - Treating a Diabetic Patient.

- We have evidence, such as, recent insulin doses, food intake, blood sugar measurements, and other physical signs.
- The task is to assess the current state of the patient, including the actual blood sugar level and insulin level.
- Given this information, the doctor (or patient) makes a decision about the patient's food intake and insulin dose.

Example - Treating a Diabetic Patient...

- The dynamic aspects of the problem are essential.
- Blood sugar levels and measurements thereof can change rapidly over time, depending on one's recent food intake and insulin doses, one's metabolic activity, the time of day, and so on.
- To assess the current state from the history of evidence and to predict the outcomes of treatment actions, we must model these changes.

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States and Observations

- The process of change can be viewed as a series of snapshots (results), describes the state of the world at a particular time.
- Each snapshot or time slice, contains a set of random variables, some of which are observable and some of which are not.

State and observation ...

- Example: **Umbrella and Rain**
- Suppose you are a security guard for some secret underground installation
- You want to know whether it is raining today
- But, your only access to the outside world occurs each morning, when you see the director coming in with, or without an umbrella.

State and observation ...

- We will assume that the same subset of variables is observable in each slice
- X_t – set of unobservable state variable at time t
- E_t – set of observable evidence variable
- The observation at time t is $E_t = e_t$ for some set of values e_t

Stationary Processes and the Markov assumption

- With the set of state and evidence variables for a given problem, we need to specify the dependencies among the variables.
- Order the variables in their natural temporal order
- Since cause usually precedes effect so we need to add the variables in causal order.

Stationary Processes and the Markov assumption...

- The set of variables is unbounded, because it includes the state and evidence variables for every time slice.
- This actually creates two problems:
  - **first**, we might have to specify an unbounded number of conditional probability tables (CPT), one for each variable in each slice;
  - **second,** each one might involve an unbounded number of parents.

Hidden Markov Model (HMM)

- **Hidden Markov Model** (HMM) is a statistical model that is used to describe the probabilistic relationship between a sequence of observations and a sequence of hidden states. It is often used in situations where the underlying system or process that generates the observations is unknown or hidden, hence it got the name "Hidden Markov Model."
- It is used to predict future observations or classify sequences, based on the underlying hidden process that generates the data.
- An HMM consists of two types of variables: hidden states and observations.
- The **hidden states** are the underlying variables that generate the observed data, but they are not directly observable.
- The **observations** are the variables that are measured and observed.

Stationary Processes and the Markov assumption...

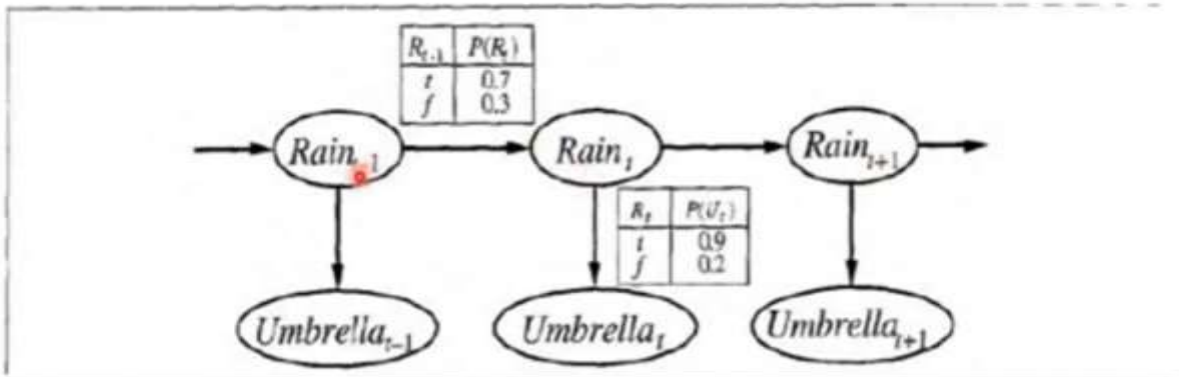

Figure 15.2 Bayesian network structure and conditional distributions describing the umbrella world. The transition model is $P(Rain_t|Rain_{t-1})$ and the sensor model is $P(Umbrella_t|Rain_t)$.