- A changing world is modelled using a random variable for each aspect of the world state at each point in time.

Time & Uncertainty

- A process can be viewed as series of snapshots, each of which describes the state of world at a particular time. Each snapshot, or time slice, contains a random set of variables, some of which are observable / some not

Stationary processes & Markov assumption

- 2 problems.
  + Processes will have variables order asking questions about conditional independence of predecessors.
  + Problem 1: set of variables are unbounded.
    * creates unbounded no. of conditional prob.
    * may involve unbounded no. of parents.
- Stationary process: Process of change that is governed by laws that don't change themselves over time! Allows to specify, eg. only for variables within "representative" time slice
- Markov assumption:
  + current state depends only one few earlier states
  + First order Markov process: state depends only on one previous state.

$$\therefore P(X_t | X_{0:t-1}) = P(X_t | X_{t-1})$$

  + Also restricting parents of evidence variables:

$$P(E_t | X_{0:t}, E_{0:t-1}) = P(E_t | X_t).$$

$P(E_t | X_t)$ is called sensor model / observation model * because it des' how evidence variables are affected by actual state of the world.

- Model can be improvised by
  + Increasing the order numbers
  + Increasing the state variables.

Inference in Temporal Models

* Inference provides an estimate of what transition occurred & of what states; these can be used to update the models. The updated model provides new estimates, & process iterates through convergance.

- Tasks in inferencing
  + Filtering / monitoring: Computes belief state,
    * Calculates posterior prob. distribution over the current state, given all evidence to date.
    * Calculates $P(X_t | e_{1:t})$
    * Almost identical calculations provides the likelihood of the evidence sequence.
  + Prediction: Calculates PDF over future state given all evidence to date,
    * $P(X_{t+k} | e_{1:t})$ from some $k > 0$.
  + Smoothing / hindsight: Calculates PDF for past state, given all evidence upto date.
    * Calculate $P(X_k | e_{1:t})$ where $0 \leq k < t$.
  + Mostly likely explanation: Given the sequence of observations, we wish to find the sequence of states that is most likely to have generated those observations.

Hidden Markov models (HMM)

- Temporal probabilistic model in which state of a process is described by single random variable

Kalman Filtering –

Temporal probability model inferencing in noisy environment. Also Dynamic Bayesian Network

- AShish R. Gavande