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Hidden Markov Models

* Reasoning over Time or Space

⇒ Often, we want to reason about a sequence of observations

{Robot Localization}

⇒ Need to introduce time (or space) into our models.

⇒ Value of X at a given time is called the State.

$$X_1 \to X_2 \to X_3 \to X_4 \dashrightarrow$$

$P(X_1)$ → {Initial state probabilities}

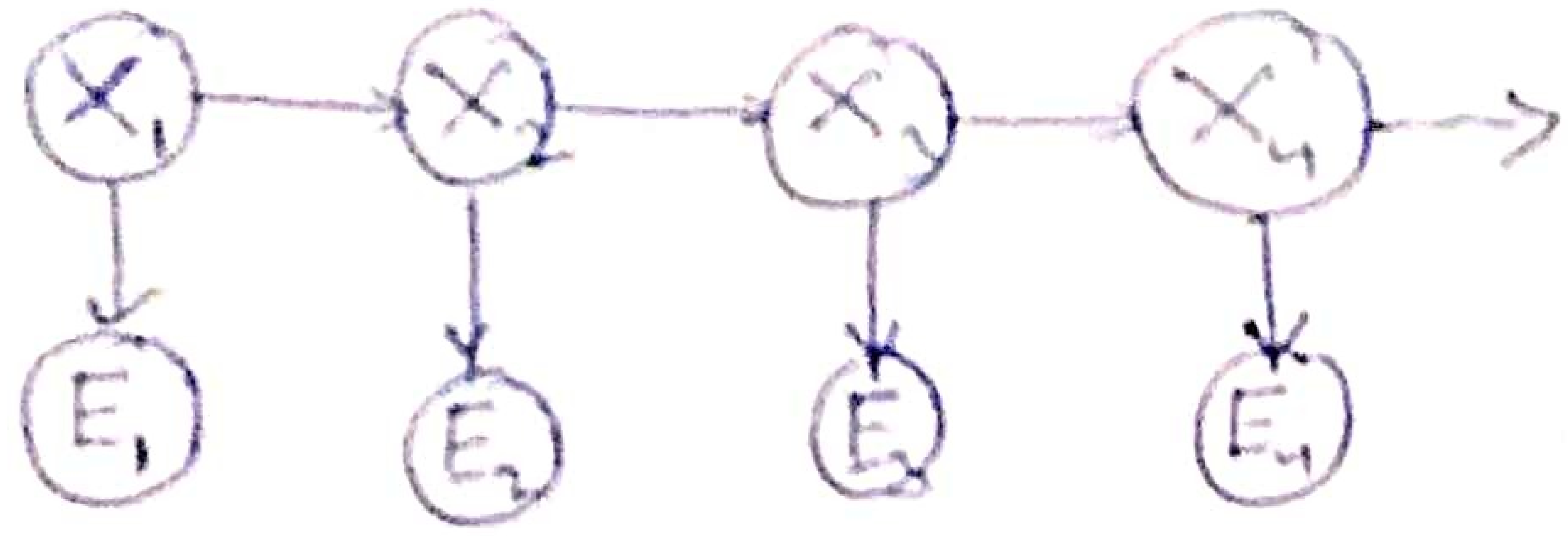
$P(X_t | X_{t-1})$ → Transition probabilities or dynamics

{Specify how the state evolves over time}

⇒ **Stationarity Assumption:** Transition probabilities stays the same all the time.

⇒ Note that the chain is just a (growable) BN.

★ Hidden Markov Models (HMMs)



★ Filtering / Monitoring

⇒ Filtering or monitoring is the task of tracking the distribution

$$B_t(x) = P_t(X_t \mid e_1, \ldots e_t) \quad \text{(The belief state)}$$

over time.

⇒ We start with $B_1(x)$ in a initial setting, usually uniform

⇒ As time passes, or we get observations, we update $B(x)$

⇒ The Kalman filter was invented in the 60s and first implemented as a method of trajectory estimation for the Apollo program.