Exam Prep Discussion 10

Markov Chain

- Represents a special relationship between variables in which the value of the current state depends only on the value of the previous state

- Markov Property: value of an S_t is independent of all previous timesteps, given S_{t-1}

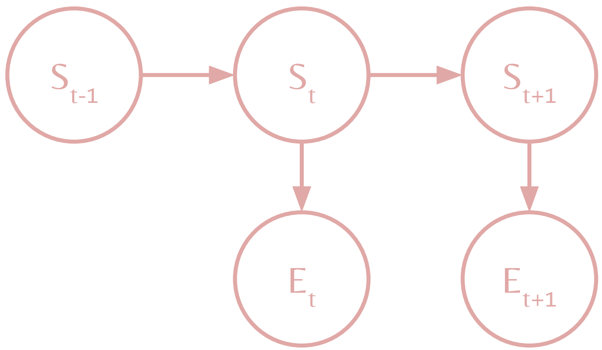
- Probability distribution at a given time t:

$$P(S_t) = \sum_{s_{t-1}} P(S_t, s_{t-1}) = \sum_{s_{t-1}} P(S_t | s_{t-1}) P(s_{t-1})$$

Hidden Markov Model

- Markov chain with hidden states and evidence states at each timestep

- Purpose: find the probability distribution of the hidden state, given what we observe in the evidence states



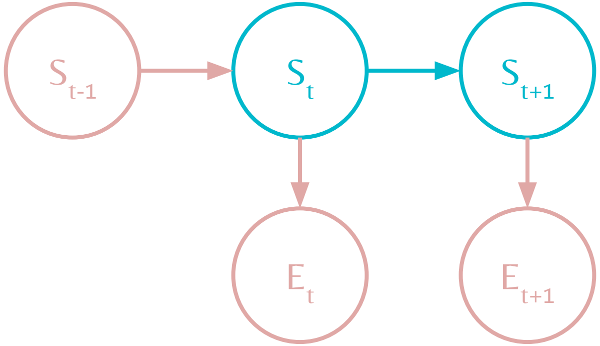
ıre synonymous with probabilities!

Time Elapse Update

- Finding belief distribution of next hidden state given the belief distribution of the current hidden state

- $$B'(S_{t+1}) = \sum_{s_t} P(S_{t+1}|s_t)B(s_t)$$

- Represents the probability that S_{t+1} takes on some value s_{t+1}, given the evidence up until just before this time (time t)



Wait, where does the "evidence" come in?
This is because **$B(s_t)$** already incorporates the distribution of **s_t** given **$e_{1:t}$**
Since we are summing **s_t** out, we get **$P(S_{t+1} | e_{1:t})$**

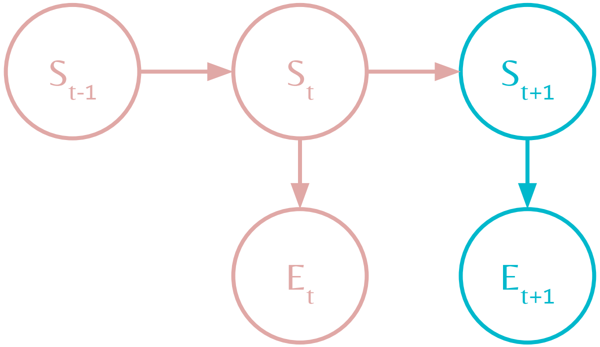
Observation Update

- Incorporating evidence; finding belief distribution of next hidden state given the evidence we've observed at that timestep

- Must factor in the probability of observing that evidence (given the value of the state)

- $B(S_{t+1}) \propto P(e_{t+1}|S_{t+1})B'(S_{t+1})$

- Represents the probability that S_{t+1} is this value s_{t+1}, given the evidence up to AND INCLUDING this time (time t+1)



Why the $\propto$ instead of **=** ?

We're leaving out a normalization factor of **$P(e_{t+1} | e_{1:t})$**; we don't care about our evidence distribution at this point in time

Particle Filtering

- Sampling an HMM via particles to obtain the belief distribution—like Bayes' net likelihood weighting sampling