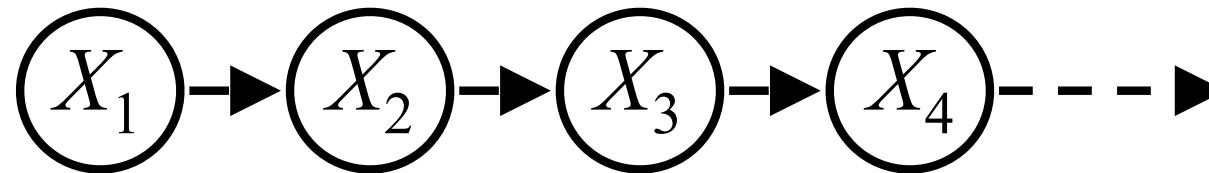


CS 188 SECTION 10

UPCOMING DEADLINES

- Practice Midterm 2 due **tonight** @ 11:59
- Midterm 2 **Wednesday, 11am–2pm**
 - The location of the exam will vary based on the first letter of your last name.
 - If the first letter is in the range A-L: go to 277 Cory
 - If the first letter is in the range M-Z: go to 145 Dwinelle
- HW 5 due **Friday** @ 11:59
- Project 5 due **Monday 8/1** @ 5pm

MARKOV MODELS



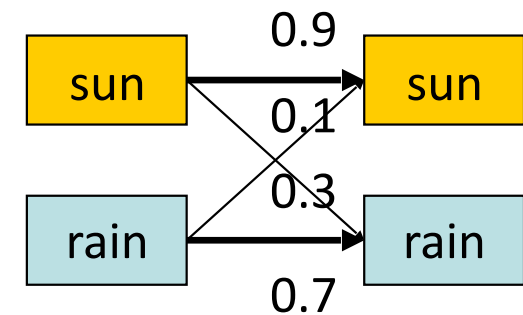
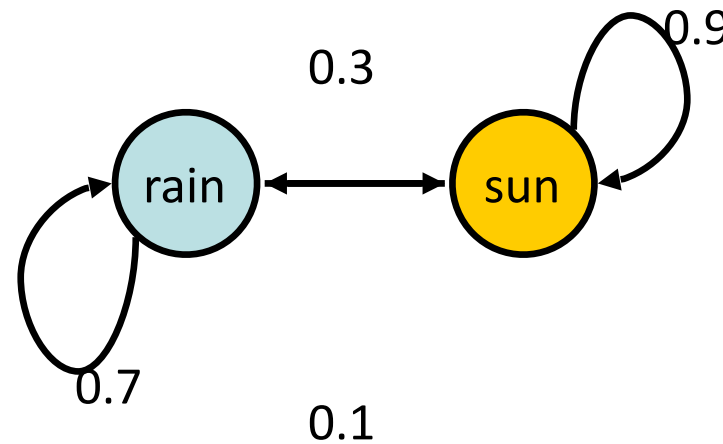
$$P(X_1) \quad P(X_t|X_{t-1})$$

Same as MDP transition model, but no choice of action

$$P(X_1, X_2, X_3, X_4) = P(X_1)P(X_2|X_1)P(X_3|X_2)P(X_4|X_3)$$

EXAMPLE

X_{t-1}	X_t	$P(X_t X_{t-1})$
sun	sun	0.9
sun	rain	0.1
rain	sun	0.3
rain	rain	0.7



$$P(X_2 = \text{sun}) = P(X_2 = \text{sun} | X_1 = \text{sun})P(X_1 = \text{sun}) + P(X_2 = \text{sun} | X_1 = \text{rain})P(X_1 = \text{rain})$$

$$0.9 \cdot 1.0 + 0.3 \cdot 0.0 = 0.9$$

STATIONARY DISTRIBUTIONS

Stationary distribution:

- The distribution we end up with is called the **stationary distribution** P_∞ of the chain
- It satisfies

$$P_\infty(X) = P_{\infty+1}(X) = \sum_x P(X|x)P_\infty(x)$$

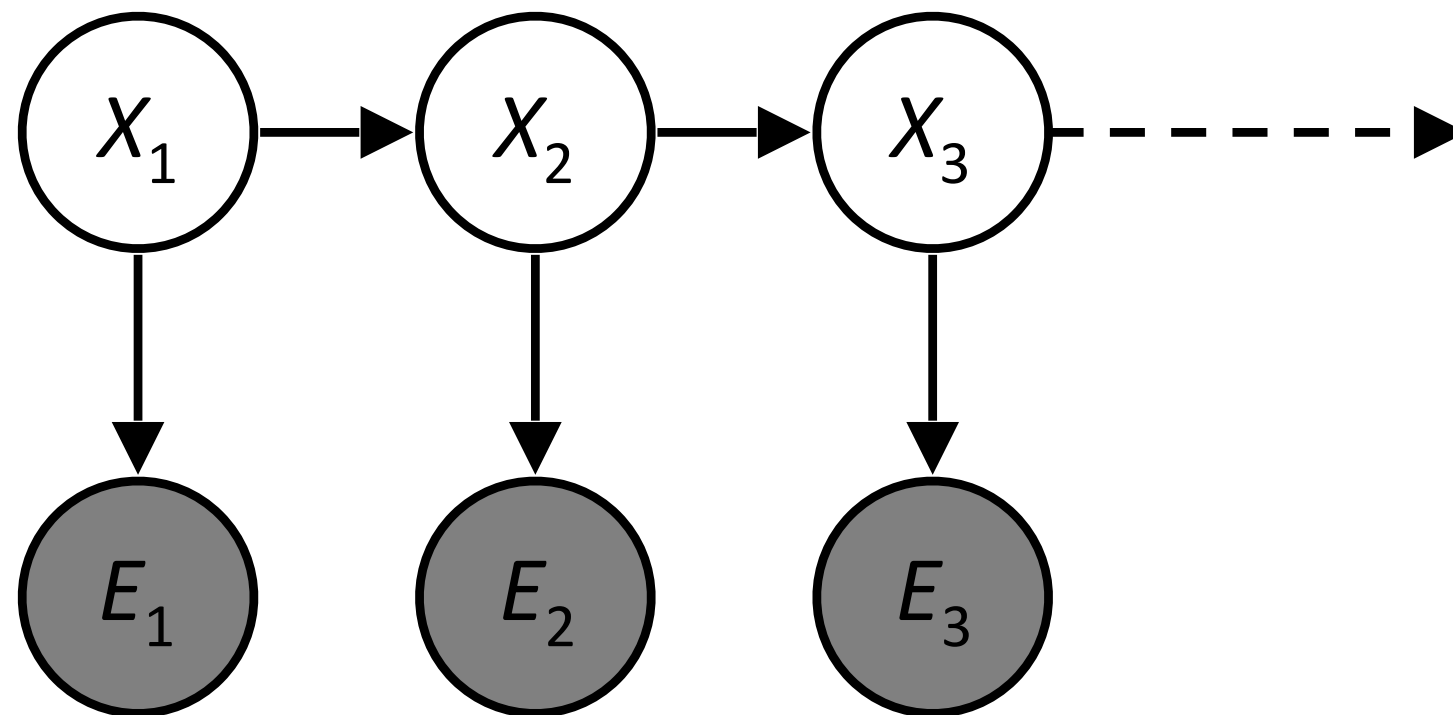
$$P_\infty(\text{sun}) = P(\text{sun}|\text{sun})P_\infty(\text{sun}) + P(\text{sun}|\text{rain})P_\infty(\text{rain})$$
$$P_\infty(\text{rain}) = P(\text{rain}|\text{sun})P_\infty(\text{sun}) + P(\text{rain}|\text{rain})P_\infty(\text{rain})$$

$$P_\infty(\text{sun}) = 0.9P_\infty(\text{sun}) + 0.3P_\infty(\text{rain})$$
$$P_\infty(\text{rain}) = 0.1P_\infty(\text{sun}) + 0.7P_\infty(\text{rain})$$

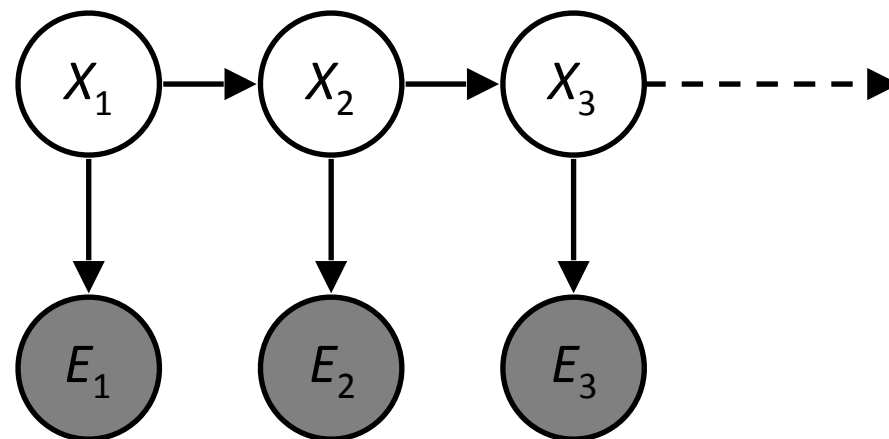
$$P_\infty(\text{sun}) = 3/4$$

$$P_\infty(\text{rain}) = 1/4$$

HMM



FORWARD ALGORITHM



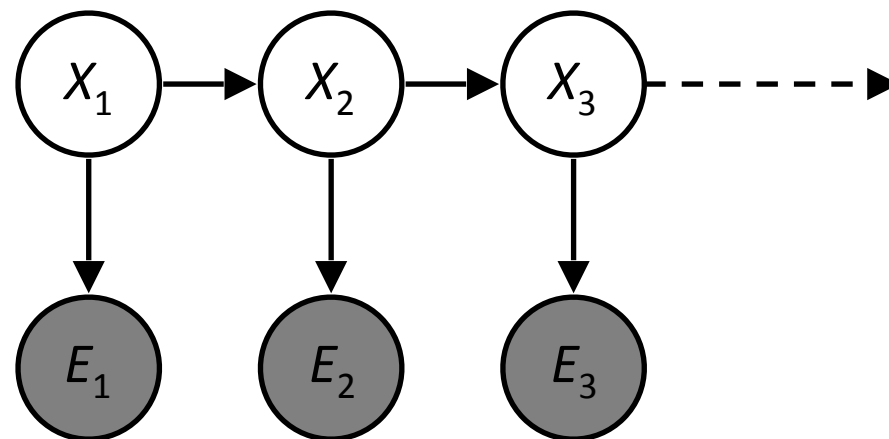
$$P(X_1|e_1)$$

$$\begin{aligned} P(x_1|e_1) &= P(x_1, e_1)/P(e_1) \\ &\propto_{X_1} P(x_1, e_1) \\ &= P(x_1)P(e_1|x_1) \end{aligned}$$

$$P(X_2)$$

$$\begin{aligned} P(x_2) &= \sum_{x_1} P(x_1, x_2) \\ &= \sum_{x_1} P(x_1)P(x_2|x_1) \end{aligned}$$

FORWARD ALGORITHM



We update for time:

$$P(x_t|e_{1:t-1}) = \sum_{x_{t-1}} P(x_{t-1}|e_{1:t-1}) \cdot P(x_t|x_{t-1})$$

We update for evidence:

$$P(x_t|e_{1:t}) \propto_X P(x_t|e_{1:t-1}) \cdot P(e_t|x_t)$$

WORKSHEET

PARTICLE FILTERING VIDEO

<https://www.youtube.com/watch?v=aUkBa1zMKv4>