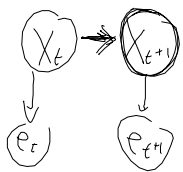**DBN 2**
Wednesday, November 2, 2016 9:27 AM

Filtering: what state am I in now? t_{+1}, gotten e_{t+1}, X_{t+1}?

$$P(X_{t+1} | e_{1:t+1}) = P(X_{t+1} | e_{1:t}, e_{t+1})$$

$$= \alpha \, P(e_{t+1} | X_{t+1}, e_{1:t}) \, P(X_{t+1} | e_{1:t}) \quad \leftarrow \text{Bayes rule}$$

$\underbrace{\qquad}_{\text{sensor updates}}$ $\underbrace{\qquad}_{\text{1-step prediction}}$

over $P(e_{t+1} | X_{t+1}, e_{1:t})$: $P(X_{t+1}, e_{1:t})$ if independent

$$= \alpha \, P(e_{t+1} | X_{t+1}) \, P(X_{t+1} | e_{1:t}) \quad \leftarrow \text{Markov Sensor assumption}$$

$$= \alpha \, P(e_{t+1} | X_{t+1}) \sum_{X_t} P(X_{t+1} | X_t, e_{1:t}) P(X_t | e_{1:t})$$

$$= \alpha \underbrace{P(e_{t+1} | X_{t+1})}_{\substack{\text{sensor} \\ \text{model lookup}}} \sum_{X_t} \underbrace{P(X_{t+1} | X_t)}_{\substack{\text{transition} \\ \text{lookup}}} \underbrace{P(X_t | e_{1:t})}_{\text{Recursive call}}$$

$P(RAIN_2 | umbrella_{1:2})$

$HOUR_0 = $ No observations
$P(RAIN_0) = \langle 0.5, 0.5 \rangle$

HOUR 1 : ~~P(Rain~~

$UMBRELLA_1 = TRUE$
$UMBRELLA_2 = TRUE$

transition $(RAIN_{t-1}) \rightarrow (RAIN_t)$

R_{t-1}	$P(R_t = TRUE | R_{t-1})$	$P(R_t = FALSE | R_{t-1})$
T	0.7	0.3
F	0.3	0.7

sensor model $(RAIN_t) \rightarrow (UMBRELLA_t)$

R_t	$P(U_t = TRUE | R_t)$	$P(U_t = FALSE | R_t)$
T	0.9	0.1
F	0.2	0.8

$P(RAIN_1 | umbrella_{0:1}) =$
$\quad \alpha \, P(umb_1 | RAIN_1) \sum_{r_0} P(RAIN_1 | r_0) P(r_0)$

$\quad \alpha \langle 0.45, 0.1 \rangle \approx \langle 0.818, 0.182 \rangle$

HOUR 2 : $P(RAIN_2 | umbrella_{0:2}) =$
$\quad \alpha \, P(umb_2 | RAIN_2) \sum_{r_1} P(RAIN_2 | r_1) P(RAIN_1 | umb_1)$

$\quad \alpha \langle 0.564, 0.0746 \rangle \approx \langle 0.883, 0.117 \rangle$

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