COMP3270 Chapter 6 Teacher Notes

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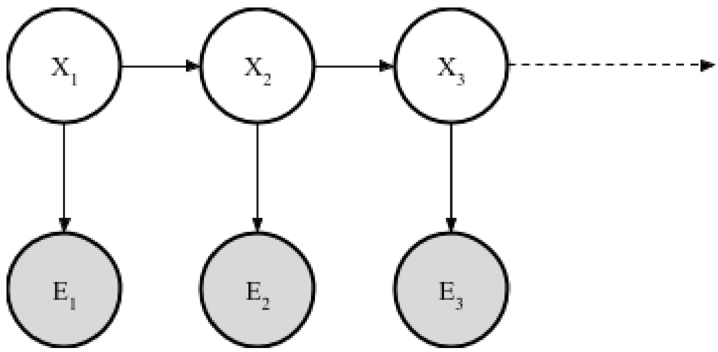

Consider the Chain Rule: P(x1, x2, x3, ...) = P(x1)P(x2|x1)P(x3|x1,x2) …

It follows from the Chain Rule
P(x1, e1, x2, e2, x3, e3) =
P(x1) P(e1|x1) P(x2|x1, e1) P(e2|x1, e1, x2) P(x3|x1, e1, x2, e2) P(e3|x1, e1, x2, e2, x3)

Assuming that:
x2 $\perp\!\!\!\perp$ e1 | x1
e2 $\perp\!\!\!\perp$ x1,e1 | x2
x3 $\perp\!\!\!\perp$ x1,e1,e2 | x2
e3 $\perp\!\!\!\perp$ x1, e1, x2, e2 | x3

It follows:

P(x1, e1, x2, e2, x3, e3) = P(x1) P(e1|x1) P(x2|x1) P(e2|x2) P(x3|x2) P(e3|x3)

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Does this mean that evidence variables are guaranteed to be independent?
A: No, they tend to correlated by the hidden state

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X_t	X_{t+1}	$P(X_{t+1}\|X_t)$
+x	+x	0.2
+x	-x	0.8
-x	+x	0.6
-x	-x	0.4

X_t	E_t	$P(E_t\|X_t)$
+x	+e	0.5
+x	-e	0.5
-x	+e	0.9
-x	-e	0.1

X_1	$P(X_1)$
+x	0.7
-x	0.3

Apply the Joint Distribution of an HMM formula!
P(X1, E1, X2, E2) = P(X1) P(E1|X1) P(X2|X1) P(E2|X2)

P(X1, E1=+e, X2,E2=-e) = P(X1) P(E1=+e | X1) P(X2 | X1) P(E2=-e|X2)

X1	X2	P(X1) P(E1=+e | X1) P(X2 | X1) P(E2=-e|X2)
+x	+x	0.7 * 0.5 * 0.2 * 0.5 = 0.035
+x	-x	0.7 * 0.5 * 0.8 * 0.1 = 0.028
-x	+x	0.3 * 0.9 * 0.6 * 0.5 = 0.081
-x	-x	0.3 * 0.9 * 0.4 * 0.1 = 0.0108

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P(X2, E1=+e, E2=-e) = ?

X2	P(X1) P(E1=+e | X1) P(X2 | X1) P(E2=-e|X2)
+x	0.7 * 0.5 * 0.2 * 0.5 + 0.3 * 0.9 * 0.6 * 0.5 = 0.035 + 0.081 = 0.116
-x	0.7 * 0.5 * 0.8 * 0.1 + 0.3 * 0.9 * 0.4 * 0.1 = 0.028 + 0.0108 = 0.0388

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B(+r) = 0.8182
B(-r) = 0.1818

B'(X_{t+1}=+r) = 0.7 * 0.8182 + 0.3 * 0.1818 = 0.6273
B'(X_{t+1}=-r) = 0.3 * 0.8182 + 0.7 * 0.1818 = 0.3727

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B(X_{t+1} = +r) $\propto$ 0.9 * 0.6273 = 0.5646
B(X_{t+1} = -r) $\propto$ 0.2 * 0.3727 = 0.0745

z = 0.5646 + 0.0745 = 0.6391

B(X_{t+1} = +r) = 0.5646 / z = 0.8834
B(X_{t+1} = -r) = 0.0745 / z = .1166