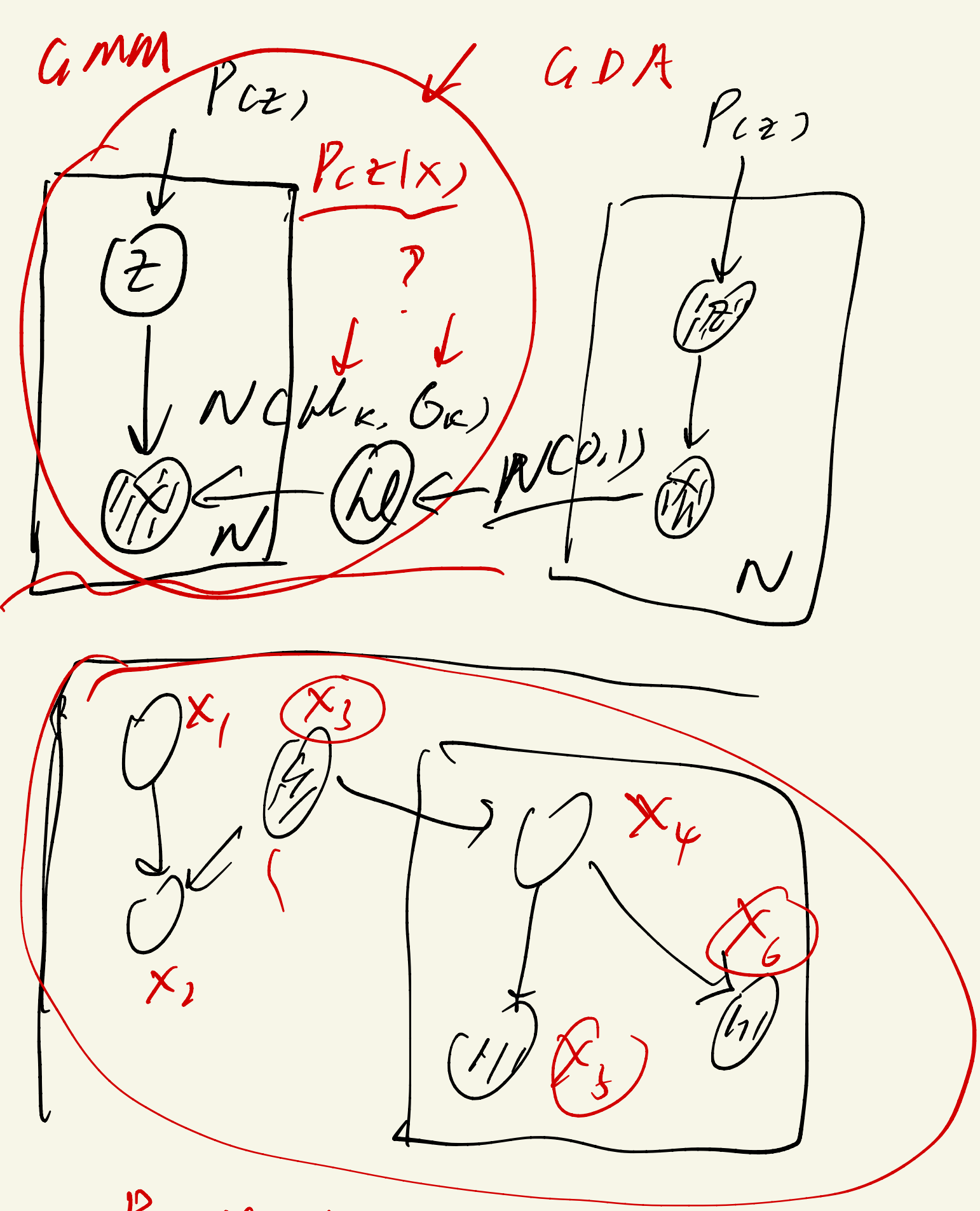
Lecture 16 HMM

$$P(x_1, \cdots x_8) = P(x_1) P(x_2|x_1) \cdots$$

$$P(x_8|x_1 \cdots x_7)$$

$$O(K^2)$$

i.i.d



$P(x_4 \mid x_3, x_5, x_6)$

LDA

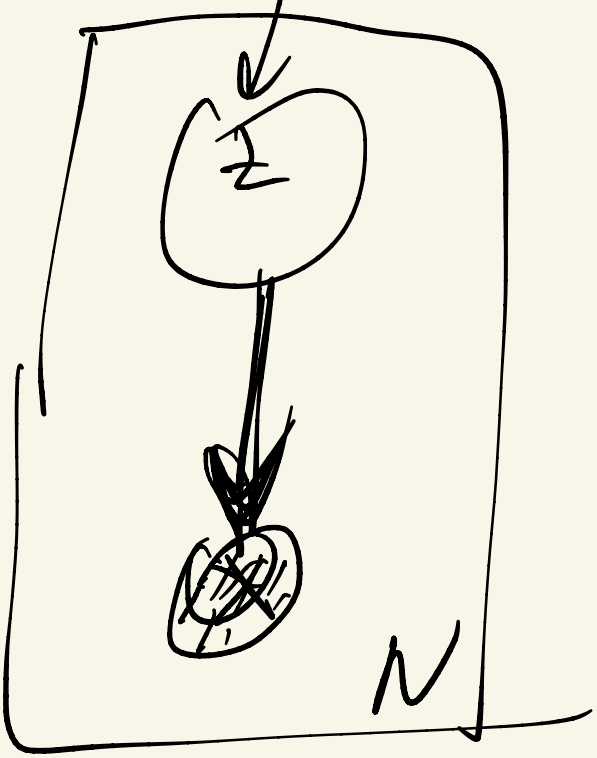
w token word

N number of word

M number of doc

VAE

$P(z) \sim N(0, 1)$



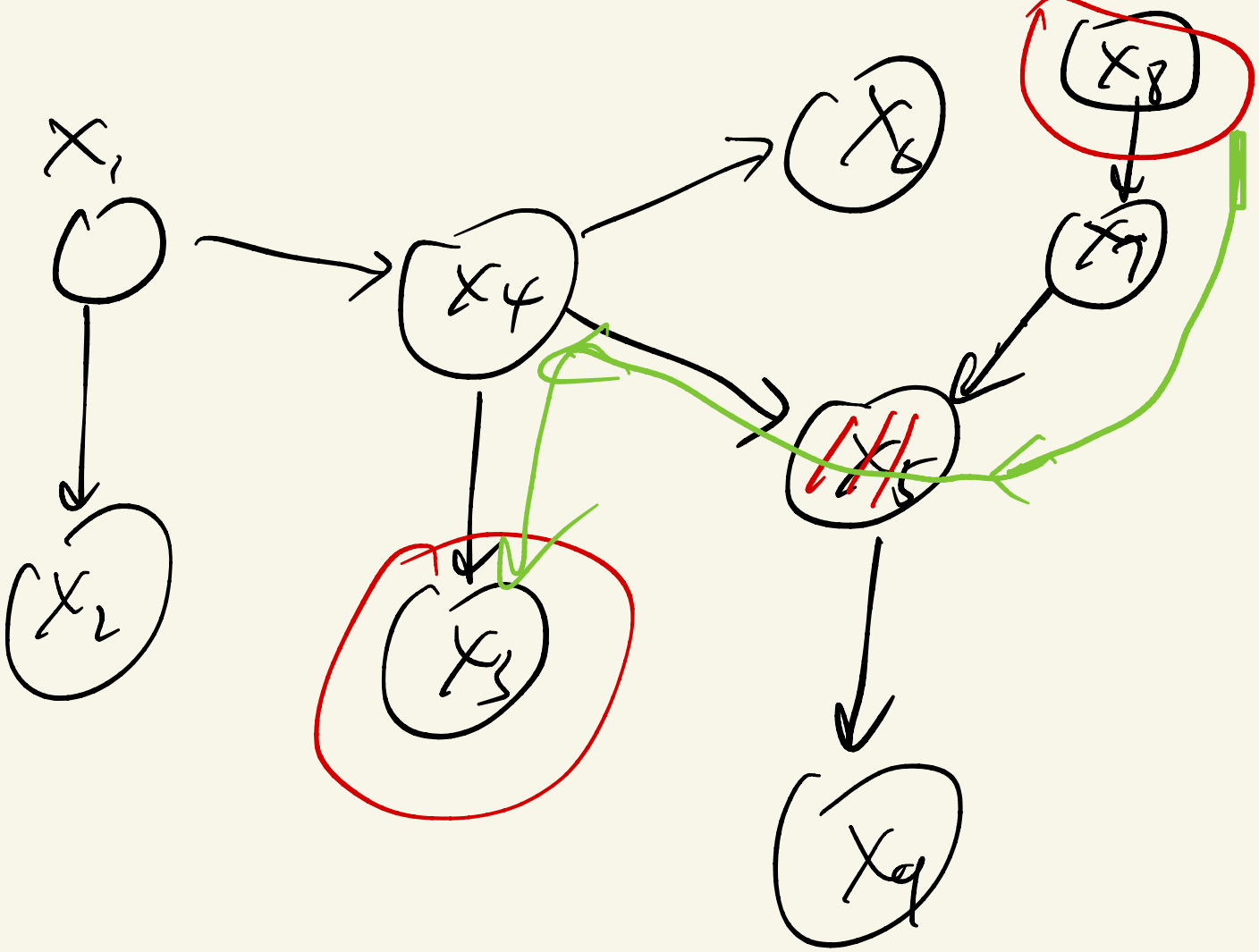
GMM

$P(z|x)$ encoder, encoding

$P(x|z)$ decoding

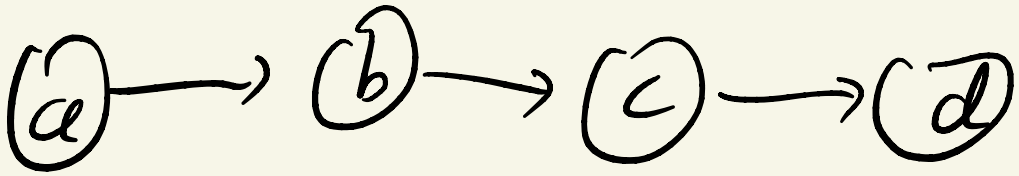
$P(z \mid x)$ exact inference

topic models

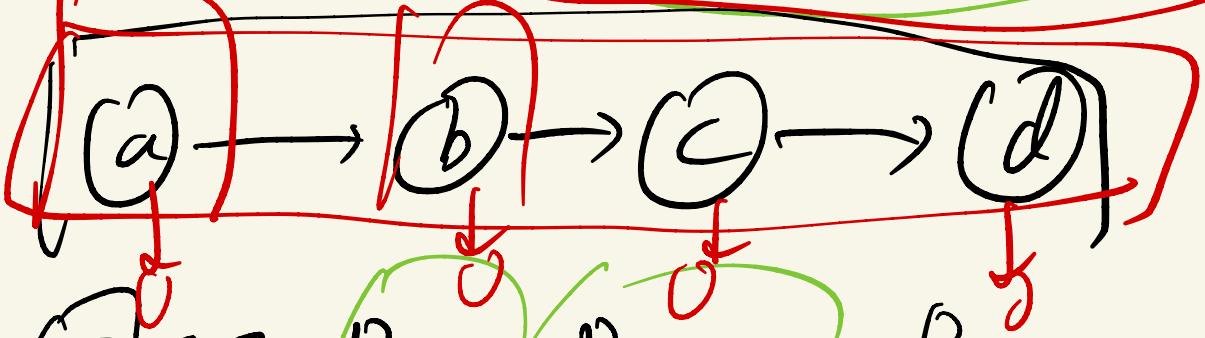

x_1
x_2
x_3
x_4
x_5
x_6
x_7
x_8
x_9

P(a --- h)

P(h)



$$P(d) = \sum_a \sum_b \sum_c P(a,b,c)$$



$$= \sum_a \sum_b \sum_c P(a) P(b|a) P(c|b) P(d|c)$$

$$= \sum_b \sum_c P(c|b) P(d|c) \sum_a P(a) P(b|a)$$

$$= \sum_b \sum_c P(c|b) P(d|c) f(b)$$

$f(b)$

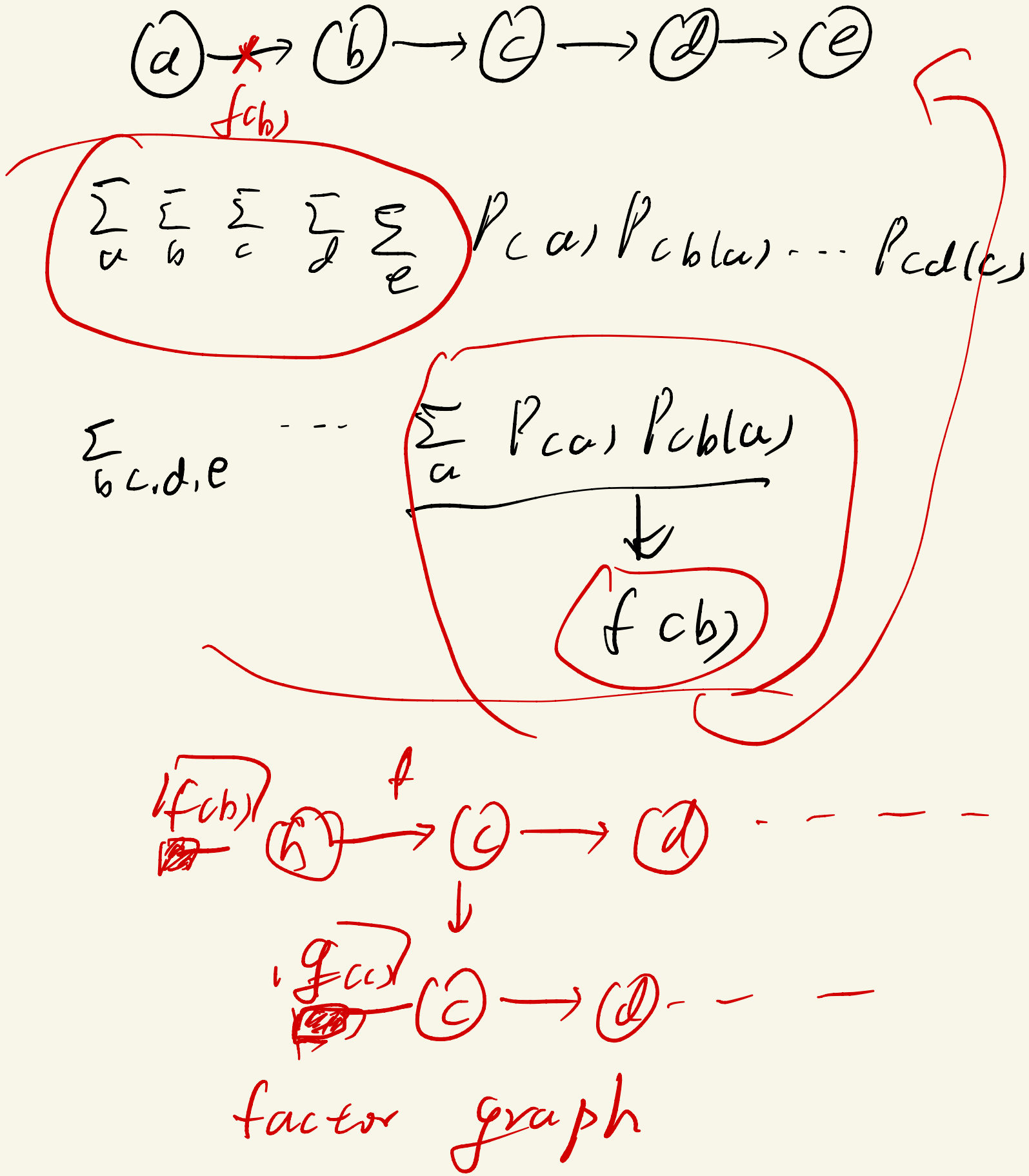
$$= \sum_c P(d|c) \sum_b P(c|b) f(b)$$

$g(c)$

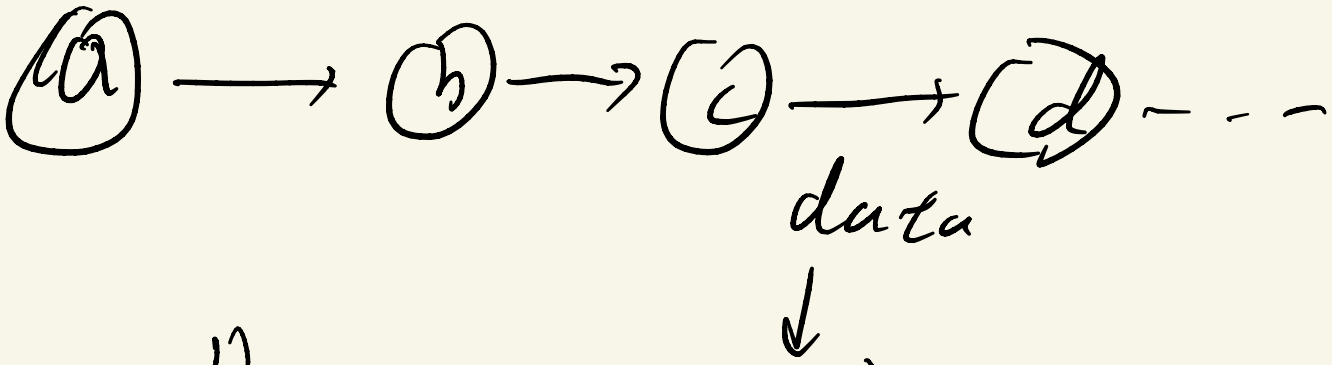
K^2

$O(K^2 \cdot T)$

$O(K^T)$


a
b
c
d
e
f(b)
$\sum_a \sum_b \sum_c \sum_d \sum_e P(a) P(b|a) \cdots P(d|c)$
$\sum_{b,c,d,e} \cdots$
$\sum_a P(a) P(b|a)$
f(b)
f(b)
b
c
d
g(c)
c
d
factor graph

$$\max_{a} \max_{b} \cdots \max_{e} P(a) P(b|a) P(c|b) \cdots$$



$$P(a \cdots f, h)$$

$$\underset{a \cdots f}{\operatorname{argmax}} P(a \cdots f, h) = MAP$$

$$P(x_n \mid x_1 \cdots x_{n-1})$$

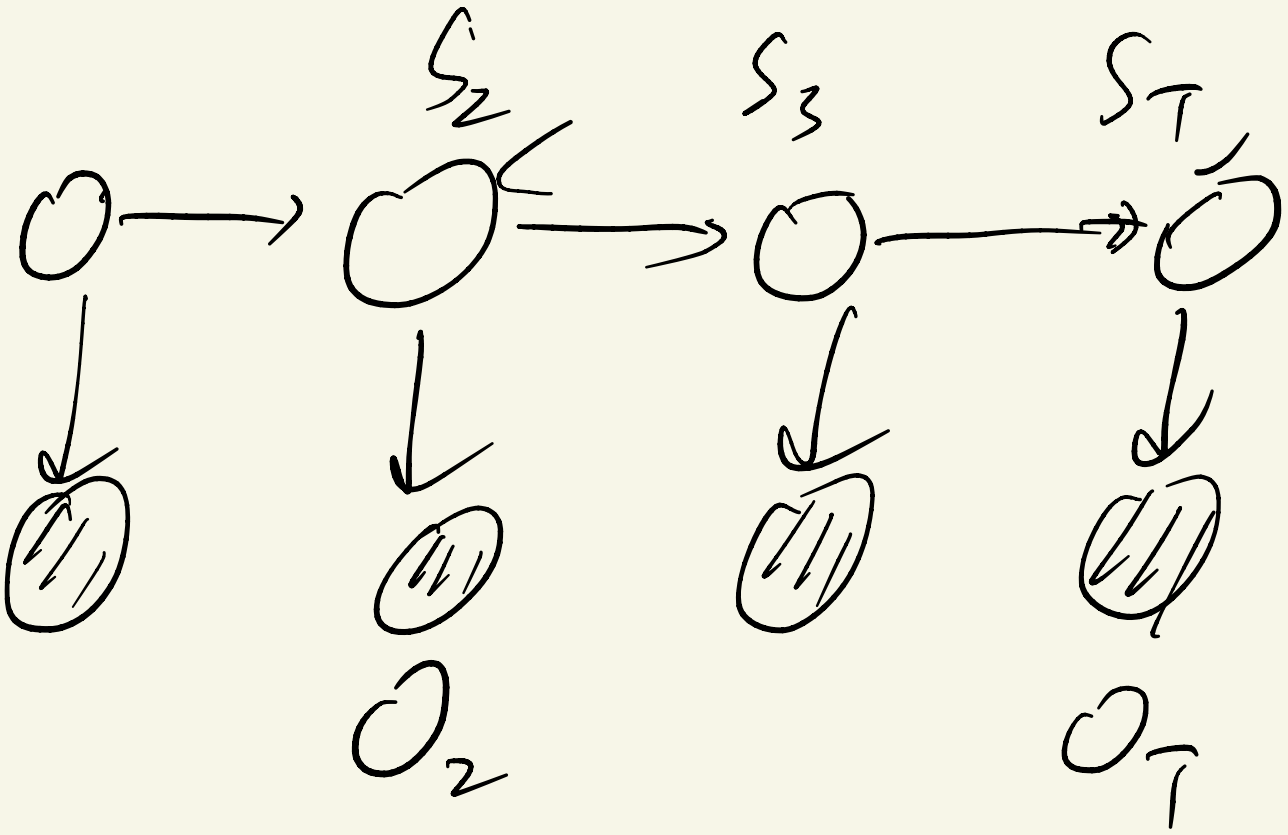
$$\Downarrow$$

$$P(x_n \mid x_{n-m} \cdots x_{n-1})$$

$$P(x_4 = 2 \mid x_3 = 1)$$

$$\Parallel$$

$$P(x_n = 2 \mid x_{n-1} = 1)$$



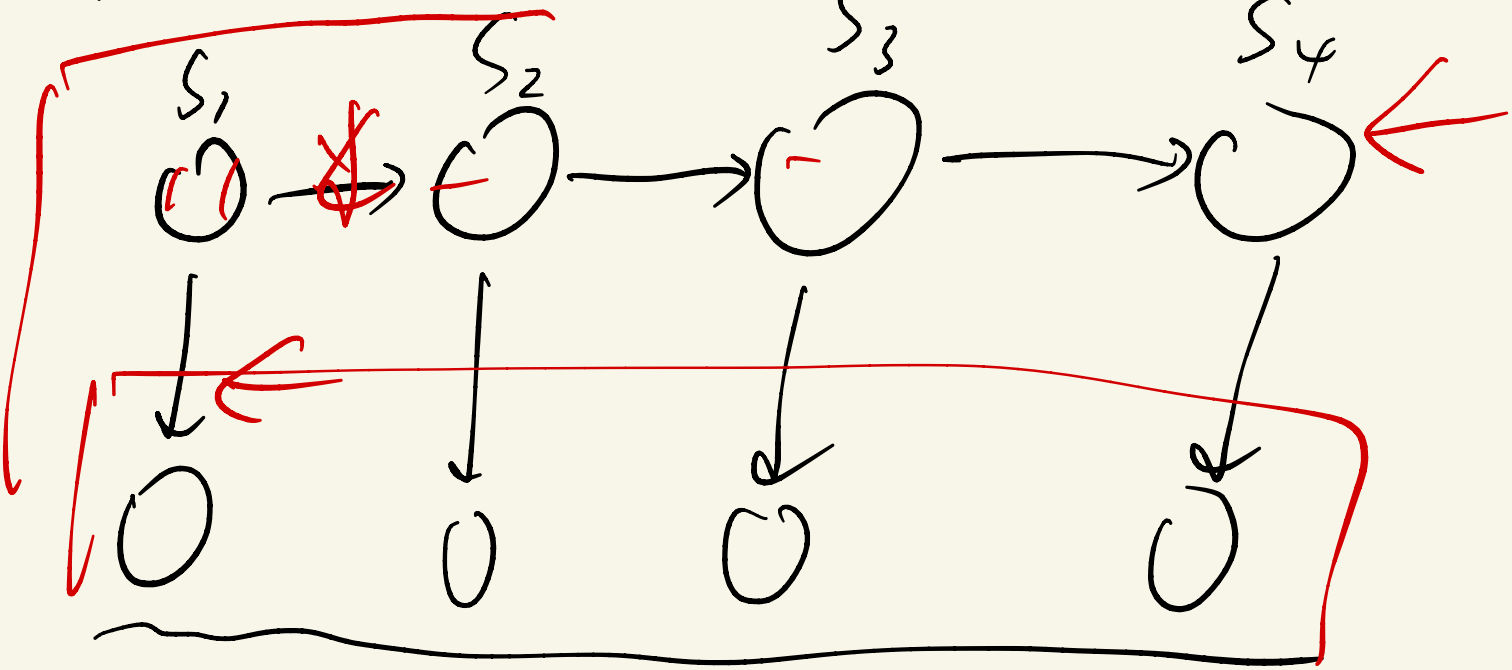
$O_2 \perp O_T$ given S_3 ✓

S is discrete

$S_{t-1} = i$ "q"

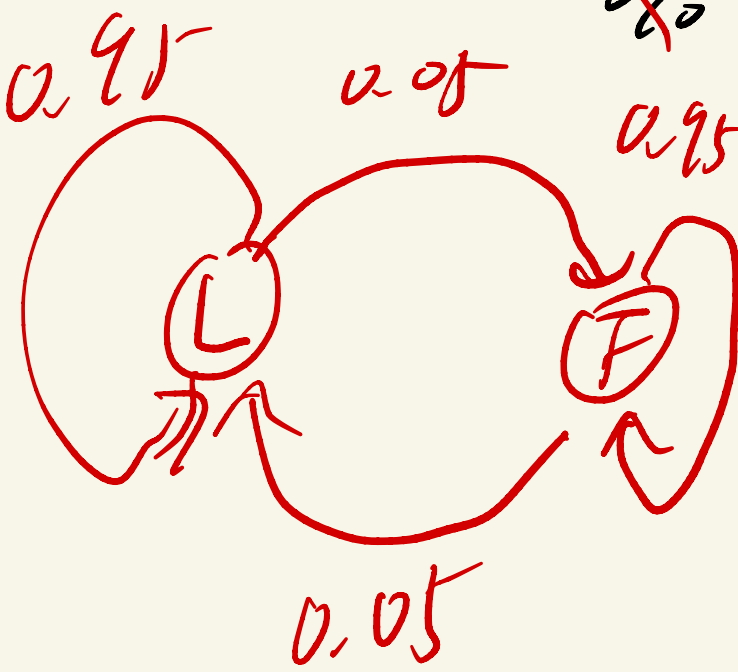
q_i

whether this is fair or loaded dice



$$P(S_t = \text{fair} \mid S_{t-1} = \text{loaded}) = 0.05$$

$P(O \mid S)$



F: fail

L: loaded

$$P(O_1 \cdots O_T)$$

$$\sum_{S_1 \cdots S_T} P(O_1 \cdots O_T, S_1, S_2 \cdots S_T)$$

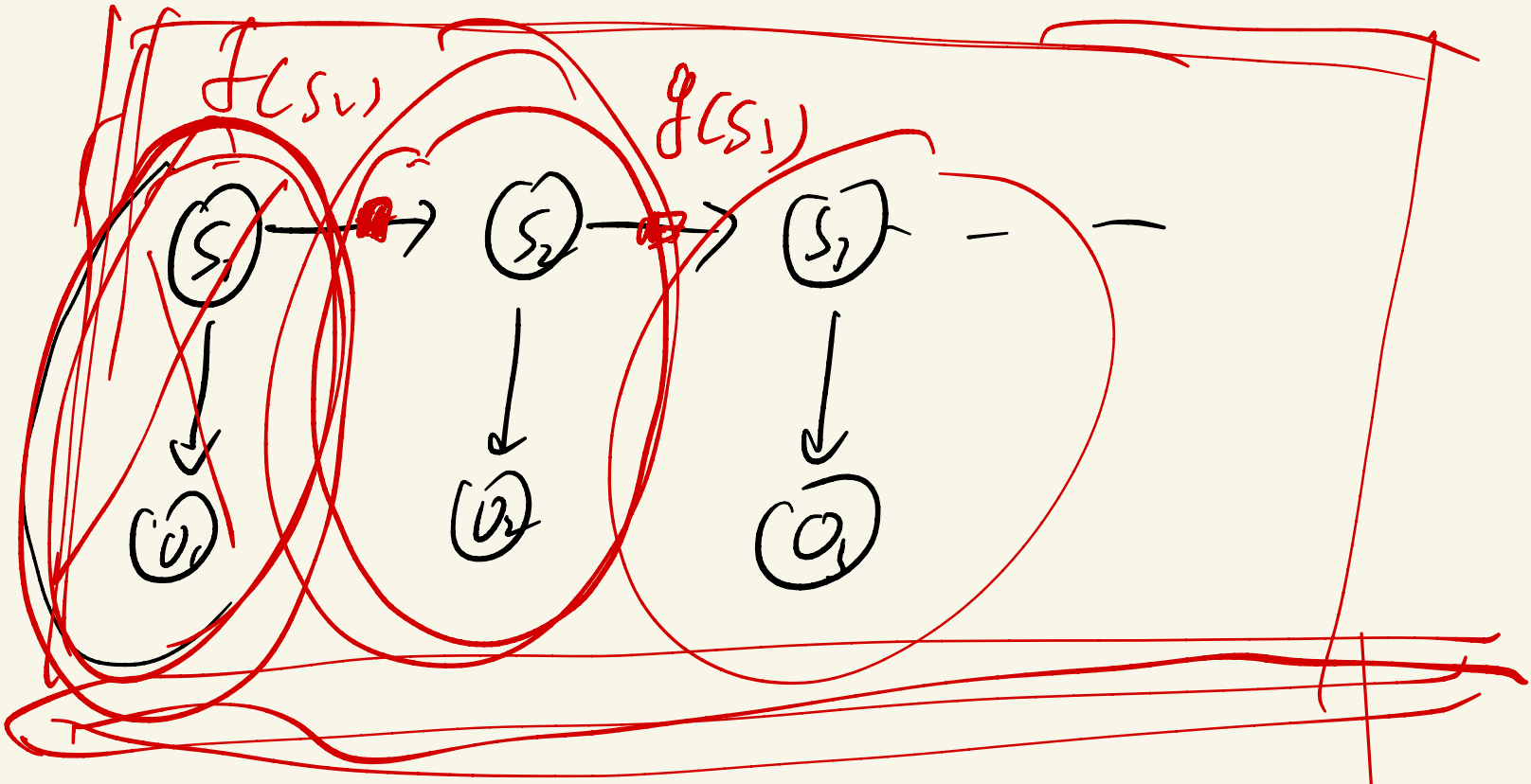
$$O(K^T)$$

$$\sum_{S_1 \cdots S_T} P(S_1) P(O_1|S_1) P(S_2|S_1) P(O_2|S_2) \cdots P(S_T|S_{T-1}) P(O_T|S_T) P(S_T|S_{T-1})$$

S_2 S_T S_{T-1}

$$= \sum_{S_2 \cdots S_T} \left(\sum_{S_1} P(S_1) P(O_1|S_1) P(S_2|S_1) \right)$$

$f(S_2)$



O(k+y)

P(o)