$P(Ch \mid F, M)$

$(3-1) \times \underbrace{3 \times 3}_{9} = 18$

$P(X_1, X_2) = \frac{1}{Z} \phi_1(X_1)\, \phi_2(X_2)\, \phi_3(X_1, X_2)$

$X_1 \in \{1, 2, \dots, M\}$

$X_2 \in \{1, 2, \dots, M\}$

$\phi_1(X_1) = \quad \phi_1(1)\, \phi_1(2) \cdots \phi_1(M)$

$\phi_2(1)\, \phi_2(2) \cdots \phi_2(M)$

$\phi_3(1,1), \phi_3(1,2), \dots, \phi_3(M,M)$

$$P(X_1, X_2) = \frac{\alpha\, \phi_1(X_1)\, \phi_2(X_2)\, \phi_3(X_1, X_2)}{\sum_{X_1'=1}^{M} \sum_{X_2'=1}^{M} \alpha\, \phi_1(X_1')\, \phi_2(X_2')\, \phi_3(X_1', X_2')}$$

$$P(X_1 \text{---} X_n) = \frac{1}{Z} \prod_{i=1}^{n} \prod_{j=i+1}^{n} \phi_{ij}(X_i, X_j)$$

$O\left(\frac{n(n-1)}{2} (M^2 - 1) \right) = O(M^2 n^2)$

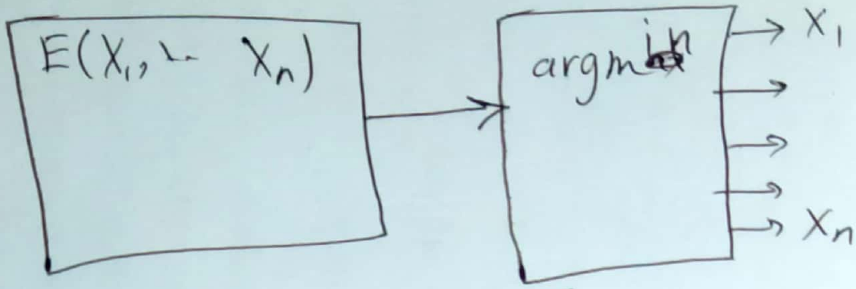
در حالت کلی $\boxed{= O(M^n) \gg O(M^2 n^2)}$

$$P(X_1, \dots, X_n) = \frac{1}{Z} \prod_{c \in C} \phi_c(X_c)$$

$\phi_c(X_c) > 0 \Rightarrow \theta_c(X_c) = \ln \phi_c(X_c)$

$$P(X_1 \text{---} X_n) = \frac{1}{Z} \prod_{c \in C} \exp(\theta_c(X_c)) = \frac{1}{Z} \exp\left(\sum_{c \in C} \theta_c(X_c)\right)$$

$$E(X_1, \ldots X_n) = \sum_i E_i(X_i) + \sum_{i,j} E_{ij}(X_i, X_j)$$



$$f(w) = \boxed{\underset{X_1 \ldots X_n}{\operatorname{argmin}}} \; \boxed{E_w(X_1, \ldots, X_n)}$$