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 $y_1, y_2, \dots, y_n$  $x$ 

$$\log \text{it}(E[Y_i|x_i]) = x_i^T \beta \quad ( )$$

$$f(Y|X, \beta)$$

ML

 $x$ 

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 $X$  $Y$ 

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$$f(Y, X | \Omega) = f(Y|X, \beta) f(X|\gamma) \quad ( )$$

$$\Omega = (\beta, \gamma)$$

$$f(X; Y)$$

$$\beta$$

$$\beta$$

$$\beta$$

$$x$$

$$x$$

$$x$$

$$A$$

$$f(Y, X, A | \Omega^*) = f(Y | X, A, \beta^*) f(X, A | \gamma^*)$$

$$\Omega^* = (\beta^*, \gamma^*)$$

$$E(Y | X, A) = \int f(Y | X, A, \beta) d\beta$$

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$$f(Y, X, A | \theta) = f(A | Y, X, \alpha) f(Y | X, \beta) f(X | \gamma)$$

$$\theta = (\alpha, \beta, \gamma)$$

$$\sum_i l_{a,y,x}(\theta | a_i, y_i, x_i) = \sum_i \{ l_{a|y,x}(\alpha | a_i, y_i, x_i) + l_{y|x}(\beta | y_i, x_i) + l_x(\gamma | x_i) \}$$

$X_i$

$$\prod f(Y_i | X_i, \beta)$$

$$\beta$$

$$\gamma$$

$$\alpha$$

$$\beta$$

$$L_{a,y,x}^0(\theta) = \sum_i \log \sum_{x_{miss}} \{ L_{a|y,x}(\alpha | a_i, y_i, x_i) \times L_{y|x}(\beta | y_i, x_i) L_x(\gamma | x_i) \}$$

$$X = (x_1, x_2, \dots, x_p)$$

$$X_{miss,i}$$

$$X_{miss,i}$$

$$\begin{matrix}
 \beta & X & \gamma = (\gamma_1, \gamma_2, \dots, \gamma_r) \\
 \text{EM} & X & \cdot \\
 & & r = 2^3 - 1 = 7 \\
 & & c_1, \dots, c_p
 \end{matrix}$$

$$\begin{matrix}
 \theta^{(t)} & L_{a,y,x}(\theta|a,Y,X) & r = c_1 \times \dots \times c_p - 1 \\
 & & f(Y|X, \beta) \\
 & & f(X|Y) \quad f(A|X,Y,\alpha) \\
 X_{obs,i} & (y_i, x_{obs,i}, a_i) & (\beta) \quad \gamma, \alpha \\
 P & X_i & X \\
 & & r+1 \quad \gamma \\
 & & x \\
 & Q(\theta|\theta^{(t)}) & f(A|X,Y,\alpha) \quad p \\
 & & (: )
 \end{matrix}$$

$$Q(\theta|\theta^{(t)}) = \sum_{i=1}^n \sum_{j=1}^{r+1} w_{ij}^{(t)} L_{a,y,x}(\theta|a_i, y_i, x^j) \\
 = \sum_{i=1}^n \sum_{j=1}^{r+1} w_{ij}^{(t)} \{ l_{a|y,x}(\alpha|a_i, y_i, x^j) + l_{y|x}(\beta|y_i, x^j) + L_x(\gamma|x^j) \} \quad ( )$$

$$\begin{matrix}
 x^j = x_{obs,i} & X_i & L_{a,y,x}(\theta|a_i, y_i, x^j) \\
 & & \theta \\
 & & x^j \\
 & & w_{ij}^{(t)} = p(x^j|a_i, y_i, x_{obs,i}, \theta^{(t)}) \\
 & & i \quad j \\
 & & W_{it}^{(t)} = 1 \quad t \\
 & & w_{ij} \\
 & & x^j \quad X_{obs,i} \\
 X_{obs,i} & & X_{obs,i} \\
 & & x^j \\
 & & ( )
 \end{matrix}$$

$$W_{ij}^{(t)} = P(x^j | a_i, y_i, x_i, \theta^{(t)})$$

$$= \begin{cases} 0 & \text{if } x^j \text{ is not compatible with } x_i \\ \frac{p(y_i | x_i^j) p(a_i | x_i^j, y_i) p(x_i^j)}{\sum_{k \in \text{obs}_i} p(y_i | x_i^k) p(a_i | x_i^k, y_i) p(x_i^k)} & \text{if } x^j \text{ is compatible with } x_i \end{cases} \quad ( )$$

$p$   $x^j$   
 $X_{obs,i}$   $j$

( ) M  $\theta$

$\beta$   $\gamma, \alpha$

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$\theta$  ( )

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 $f(A|X, Y, \alpha), f(X; \delta)$ 

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 $f(A|Y, X)$ 

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