HMM Forward Variable $\alpha_k(x) = P(y_1 \dots y_k, X_k = x)$

$(y_1 \dots y_k)$

$\alpha_t(x_1)$

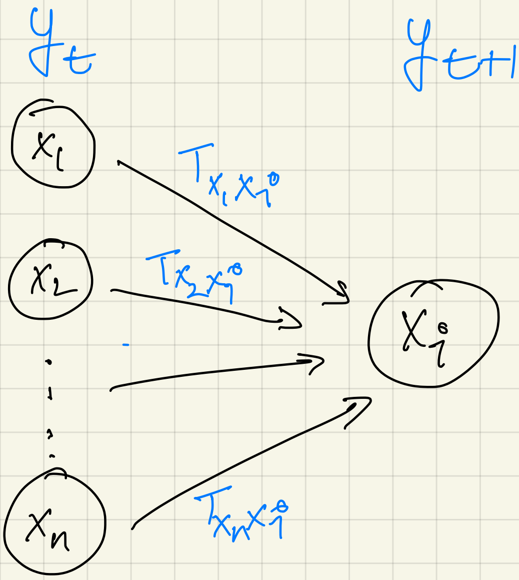
$P(y_1 \dots y_t, X_t = x_1)$

$\alpha_t(x_2)$

$P(y_1 \dots y_t, X_t = x_2)$

$\alpha_t(x_n)$

$P(y_1 \dots y_t, X_t = x_n)$



$\alpha_{t+1}(x_j)$

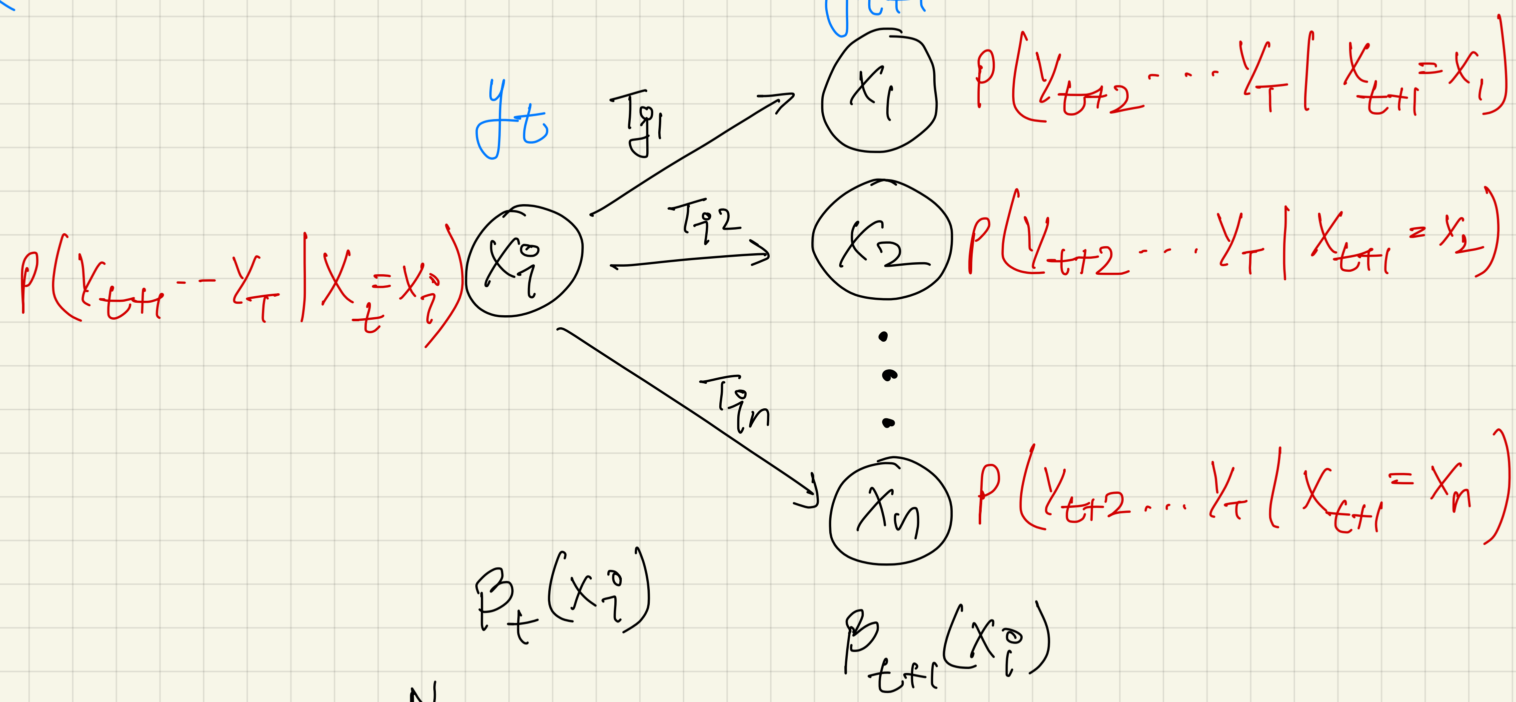
$P(y_1 \dots y_{t+1}, X_{t+1} = x_j)$

$\alpha_t(x_i)$

(t)

$$\alpha_{t+1}(x_j) = M_{x_j y_{t+1}} \sum_{i=1}^{n} \alpha_t(x_i) \cdot T_{x_i x_j}$$

$$\beta_k(x) = P(y_{k+1} \dots y_T \mid X_k = x)$$



$$\beta_t(x_i) = \sum_{i=1}^{N} \beta_{t+1}(x_i) \cdot T_{x_i x_i} \cdot M_{x_i y_{t+1}}$$