

NPDSLDA - Parameter Updates.

✓ 1. $u_{k1} = v_{01} + \sum_{j=1}^D \sum_{t=1}^T \varphi_{jtk_1} \quad \forall k_1 \in \{1, 2, \dots, K_1\}$

✓ 2. $v_{k1} = v_{02} + \sum_{j=1}^D \sum_{t=1}^T \left(\sum_{k=1+K_1}^{K_1} \varphi_{jtk_k} \right)$

✓ 3. $a_{jt} = \alpha_{01} + \sum_{n=1}^{N_j} \delta_{jnt} \quad \text{take first } T \text{ components only}$
 $\forall j \in \{1, 2, \dots, D\}$

✓ 4. $b_{jt} = \alpha_{02} + \sum_{n=1}^{N_j} \left(\sum_{t'=1+t}^T \delta_{jnt'} \right) \quad \text{take first } T \text{ components only}$
 $\forall t \in \{1, 2, \dots, T\}$

5. $\lambda_{k1v}^{(1)} = \eta_v + \sum_{j=1}^D \sum_{n=1}^{N_j} \left(\sum_{t=1}^T \delta_{jnt} \cdot \varphi_{jtk_1} \right) \mathbb{I}_{\{w_{jn}=v\}} \quad \text{multiply by count}$
 $\forall k_1 \in \{1, 2, \dots, K_1\}, \forall v \in \{1, 2, \dots, V\}$

6. $\lambda_{k2v}^{(2)} = \eta_v + \sum_{j=1}^D \sum_{n=1}^{N_j} \delta_{jnk_2} \mathbb{I}_{\{w_{jn}=v\}} \quad \text{multiply by count}$
 $\forall k_2 \in \{1, 2, \dots, K_2\}, \forall v \in \{1, 2, \dots, V\}$

✓ 7. $\mu_{jk_2} = \mu_{k_2} + \sum_{n=1}^{N_j} \delta_{jnk_2} \quad \text{take last } k_2 \text{ components}$
 $\forall j \in \{1, 2, \dots, D\}, \forall k_2 \in \{1, 2, \dots, K_2\}$

8. $\log \varphi_{jtk_1} \propto \left[\psi(u_{k1}) + \sum_{t=1}^{(k_1-1)} \psi(v_{-t}) - \sum_{t=1}^{k_1} \psi(u_t + v_t) \right]$
 \downarrow
 $\text{take first } T \text{ components only}$
 multiply by count
 $+ \sum_{n=1}^{N_j} \delta_{jnt} \sum_{v=1}^V \mathbb{I}_{\{w_{jn}=v\}} \left[\psi(\lambda_{k1v}^{(1)}) - \psi\left(\sum_{v=1}^V \lambda_{k1v}^{(1)}\right) \right]$
 $\forall j \in \{1, 2, \dots, D\}, \forall t \in \{1, 2, \dots, T\}, \forall k_1 \in \{1, 2, \dots, K_1\}$

9. (a) $\log \delta_{jnt} \propto \log(1-\epsilon) + \left[\psi(a_{jt}) + \sum_{t'=1}^{(t-1)} \psi(b_{jt'}) - \sum_{t'=1}^t \psi(a_{jt'} + b_{jt'}) \right]$
 $+ \left(\sum_{k=1}^{K_1} \varphi_{jtk_k} \right) \sum_{v=1}^V \mathbb{I}_{\{w_{jn}=v\}} \left[\psi(\lambda_{k1v}^{(1)}) - \psi\left(\sum_{v=1}^V \lambda_{k1v}^{(1)}\right) \right]$
 $\forall t \in \{1, 2, \dots, T\}, \forall j \in \{1, 2, \dots, D\}, \forall n \in \{1, 2, \dots, N_j\}$

(b) $\log \delta_{jnk_2} \propto \log \epsilon + \left[\psi(\mu_{jk_2}) - \psi\left(\sum_{k_2=1}^{K_2} \mu_{jk_2}\right) \right] + \sum_{v=1}^V \mathbb{I}_{\{w_{jn}=v\}} \left[\psi(\lambda_{k2v}^{(2)}) - \psi\left(\sum_{v=1}^V \lambda_{k2v}^{(2)}\right) \right]$
 $\forall j \in \{1, 2, \dots, D\}, \forall n \in \{1, 2, \dots, N_j\}, \forall k_2 \in \{1, 2, \dots, K_2\}$