

$$\min \sum_{i \in \mathcal{N}} \sum_{j \in \mathcal{N}} \sum_{v \in \mathcal{V}} \sum_{d=1}^D \sum_{t=1}^T C_{ij} x_{ij}^{vdt} \quad (1)$$

subject to

$$\sum_{j \in \mathcal{N}} \sum_{v \in \mathcal{V}} \sum_{d=1}^D \sum_{t=1}^T x_{ij}^{vdt} = 1, \quad i \in \mathcal{O} \quad (2)$$

$$\sum_{j \in \mathcal{N}} x_{ij}^{vdt} = \sum_{j \in \mathcal{N}} x_{ji}^{vdt}, \quad i \in \mathcal{O}, \quad v \in \mathcal{V}, \quad d = 1 \dots D, \quad t = 1 \dots T \quad (3)$$

$$\sum_{v \in \mathcal{V}} \sum_{d=1}^D w_{H_v}^{vdt} = 0 \quad (4)$$

$$x_{H_v j}^{vdt} (TT_{H_v j} - w_j^{vdt}) \leq 0, \quad j \in \mathcal{O}, \quad v \in \mathcal{V}, \quad d = 1 \dots D \quad (5)$$

$$x_{ij}^{vdt} (w_i^{vdt} + VT + \sum_{k \in \mathcal{K}} LT_{a_k} DEL_{ki} + TT_{ij} - w_j^{vdt}) \leq 0, \\ i \in \mathcal{O}, \quad j \in \mathcal{N}, \quad v \in \mathcal{V}, \quad d = 1 \dots D, \quad t = 1 \dots T \quad (6)$$

$$x_{sj}^{vdt} (w_s^{vdt, t-1} + CL + TT_{sj} - w_j^{vdt}) \leq 0, \\ s \in \mathcal{S}, \quad j \in \mathcal{O}, \quad v \in \mathcal{V}, \quad d = 1 \dots D, \quad t = 2 \dots T \quad (7)$$

$$w_s^{vdt} - w_i^{vdt} \leq W_{MAX}, \quad s \in \mathcal{S}, \quad i \in \mathcal{O}, \quad v \in \mathcal{V}, \\ d = 1 \dots D, \quad t = 1 \dots T \quad (8)$$

$$w_s^{vdt} \leq W_{END}, \quad s \in \mathcal{S}, \quad v \in \mathcal{V}, \quad d = 1 \dots D, \quad t = 1 \dots T \quad (9)$$

$$\sum_{g \in \mathcal{G}_v} f_{kgi}^{dt} = x_{ij}^{vdt} DEL_{ki}, \quad k \in \mathcal{K}, \quad i \in \mathcal{O}, \\ v \in \mathcal{V}, \quad d = 1 \dots D, \quad t = 1 \dots T \quad (10)$$

$$\sum_{a=1}^A e_{ag}^{dt} \leq 1, \quad g \in \mathcal{G}, \quad d = 1 \dots D, \quad t = 1 \dots T \quad (11)$$

$$\sum_{i \in \mathcal{O}} \sum_{k \in \mathcal{K}} f_{kgi}^{dt} SR_k \leq FL_g, \quad g \in \mathcal{G}, \quad d = 1 \dots D, \quad t = 1 \dots T \quad (12)$$

$$\sum_{t=1}^T \sum_{d=1}^D \sum_{p \in \mathcal{P}} e_{\text{bov}, UP_p}^{dt} = 0 \quad (13)$$

$$\sum_{i \in \mathcal{O}} \sum_{k \in \mathcal{K}} f_{kUP_p i}^{dt} \leq M(HS_p + (1 - e_{\text{bov}, LO_p}^{dt})), \quad p \in \mathcal{P},$$

$$d = 1 \dots D, \quad t = 1 \dots T \quad (14)$$

$$\sum_{k \in \mathcal{K}_a} \sum_{i \in \mathcal{O}} f_{kgi}^{dt} \leq M e_{ag}^{dt}, \quad a = 1 \dots A, \quad g \in \mathcal{G},$$

$$d = 1 \dots D, \quad t = 1 \dots T \quad (15)$$

$$\sum_{k \in \mathcal{K}} f_{kgi}^{dt} \leq M z_{gi}^{dt}, \quad i \in \mathcal{O}, \quad g \in \mathcal{G}, \quad d = 1 \dots D, \quad t = 1 \dots T \quad (16)$$

$$\sum_{g \in \mathcal{G}_v} \left(\sum_{a=1}^A e_{ag}^{dt} \right) z_{gi}^{dt} \leq 1, \quad i \in \mathcal{O}, \quad v \in \mathcal{V}, \quad d = 1 \dots D, \quad t = 1 \dots T \quad (17)$$

$$x_{ij}^{V_g dt} z_{gj}^{dt} \leq x_{ij}^{V_g dt} z_{gi}^{dt}, \quad i, j \in \mathcal{O}, \quad g \in \mathcal{G}, \quad d = 1 \dots D, \quad t = 1 \dots T \quad (18)$$

$$z_{UP_p i}^{dt} \leq z_{LO_p i}^{dt}, \quad i \in \mathcal{O}, \quad p \in \mathcal{P}, \quad d = 1 \dots D, \quad t = 1 \dots T \quad (19)$$

$$z_{LO_{FR_v} i}^{dt} \leq z_{UP_{MID_v} i}^{dt}, \quad i \in \mathcal{O}, \quad v \in \mathcal{V}, \quad d = 1 \dots D, \quad t = 1 \dots T \quad (20)$$

$$z_{LO_{MID_v} i}^{dt} \leq z_{UP_{RE_v} i}^{dt}, \quad i \in \mathcal{O}, \quad v \in \mathcal{V}, \quad d = 1 \dots D, \quad t = 1 \dots T \quad (21)$$

$$\sum_{j \in \mathcal{O}} x_{H_v j}^{vd1} \leq 1, \quad v \in \mathcal{V}, \quad d = 1 \dots D \quad (22)$$

$$\sum_{j \in \mathcal{O}} x_{H_v j}^{vd1} \geq \sum_{j \in \mathcal{O}} x_{s_j}^{vd2}, \quad v \in \mathcal{V}, \quad d = 1 \dots D \quad (23)$$

$$\sum_{j \in \mathcal{O}} x_{s_j}^{vd, t-1} \geq \sum_{j \in \mathcal{O}} x_{s_j}^{vdt}, \quad v \in \mathcal{V}, \quad d = 1 \dots D, \quad t = 3 \dots T \quad (24)$$

$$\sum_{v \in \mathcal{V}} \sum_{j \in \mathcal{O}} \sum_{d=1}^D \sum_{t=2}^T x_{H_v j}^{vdt} = 0 \quad (25)$$

$$\sum_{i \in \mathcal{N}} \sum_{v \in \mathcal{V}} \sum_{d=1}^D \sum_{t=1}^T x_{i H_v}^{vdt} = 0 \quad (26)$$

$$\sum_{s \in \mathcal{S}} \sum_{j \in \mathcal{O}} \sum_{v \in \mathcal{V}} \sum_{d=1}^D x_{sj}^{vd1} = 0 \quad (27)$$

$$\sum_{j \in \mathcal{O}} \sum_{v \in \mathcal{V}} \sum_{d=1}^D \sum_{t=1}^T x_{ji}^{vdt} = 0, \quad i \in \mathcal{B} \quad (28)$$

$$\sum_{j \in \mathcal{O}} \sum_{v \in \mathcal{V}} \sum_{d=1}^D \sum_{t=1}^T x_{ij}^{vdt} = 0, \quad i \in \mathcal{I} \quad (29)$$

$$i_{a0} = I_a^{INIT}, \quad a = 1 \dots A \quad (30)$$

$$i_{aD} = I_a^{END}, \quad a = 1 \dots A \quad (31)$$

$$i_{ad} \leq I_a^{MAX}, \quad a = 1 \dots A, \quad d = 1 \dots D-1 \quad (32)$$

$$i_{ad} \leq SL_{a,d+1}, \quad a = 1 \dots A, \quad d = 1 \dots D-1 \quad (33)$$

$$i_{a,d-1} + \sum_{k \in K_a} \sum_{g \in \mathcal{G}} \sum_{i \in \mathcal{O}} \sum_{t=1}^T f_{kgi}^{dt} - SL_{ad} = i_{ad}, \quad a = 1 \dots A, \quad d = 1 \dots D \quad (34)$$

$$x_{ij}^{vdt} \in \{0, 1\}, \quad i, j \in \mathcal{N}, \quad v \in \mathcal{V}, \quad d = 1 \dots D, \quad t = 1 \dots T \quad (35)$$

$$w_i^{vdt} \geq 0, \quad i \in \mathcal{N}, \quad v \in \mathcal{V}, \quad d = 1 \dots D, \quad t = 1 \dots T \quad (36)$$

$$e_{ag}^{dt} \in \{0, 1\}, \quad a = 1 \dots A, \quad g \in \mathcal{G}, \quad d = 1 \dots D, \quad t = 1 \dots T \quad (37)$$

$$z_{gi}^{dt} \in \{0, 1\}, \quad g \in \mathcal{G}, \quad i \in \mathcal{O}, \quad d = 1 \dots D, \quad t = 1 \dots T \quad (38)$$

$$f_{kgi}^{dt} \geq 0, \quad k \in \mathcal{K}, \quad g \in \mathcal{G}, \quad i \in \mathcal{O}, \quad d = 1 \dots D, \quad t = 1 \dots T \quad (39)$$

$$i_{ad} \geq 0, \quad a = 1 \dots A, \quad d = 1 \dots D \quad (40)$$