$$\begin{aligned}
\text{maximize} \quad & \sum_{t=1}^{48}\sum_{\Omega\in\omega}\gamma_{(\omega)}^{(t)}\Bigg[\sum_{u\in\mathcal{L}}\sum_{m\in BM_u}\alpha_u P_{u,m}^{A(t)} - \sum_{u\in\mathcal{L}}\sum_{i\in\mathcal{S}_u} C_{u,i}^{DR(t)} P_{u,i(\omega)}^{DR(t)} \\
& + \sum_{u\in\mathcal{L}}\lambda_{u(\omega)}^{(t)Bal+}P_{u(\omega)}^{(t)Bal+} - \sum_{u,\in\mathcal{L}}\lambda_{u(\omega)}^{(t)Bal-}P_{u(\omega)}^{(t)Bal-}\Bigg] && (1)\\
\text{subject to} \quad & 0 \le P_{u,i(\omega)}^{DR(t)} \le \overline{P_{u,i(\omega)}^{DR(t)}},\ \forall u,t\in\mathcal{L},\ \forall i\in\mathcal{S}_u, \forall\omega\in\Omega && (2)\\
& \sum_{i\in\mathcal{S}_u} P_{u,i}^{DR(t)} - P_{u(\omega)}^{(t)Bal+} + P_{u(\omega)}^{(t)Bal-} = \sum_{m\in BM_u} P_{u,m}^{A(t)},\ \forall u,t\in\mathcal{L},\ \forall\omega\in\Omega && (3)\\
& P_{u(\omega)}^{(t)Bal+}P_{u(\omega)}^{(t)Bal-} = 0,\ \forall u,t\in\mathcal{L},\ \forall\omega\in\Omega && (4)\\
& 0 \le P_{u(\omega)}^{(t)Bal+}, P_{u(\omega)}^{(t)Bal-}, \lambda_{u,m}^{A(t)},\ \forall u,t\in\mathcal{L},\ m\in BM_u,\ \forall\omega\in\Omega && (5)
\end{aligned}$$

$$\begin{aligned}
\text{minimize} & \sum_{u\in\mathcal{L}}\sum_{m\in BM_u}\lambda_{u,m}^{A(t)}P_{u,m}^{A(t)} + \sum_{u\in\mathcal{L}}\sum_{o\in BO_u}\lambda_{u,o}^{G(t)}P_{u,o}^{G(t)} - \sum_{u,t\in\mathcal{L}}\sum_{n\in BN_u}\lambda_{u,n}^{D(t)}P_{u,n}^{D(t)} && (6)\\
\text{subject to} \quad & \sum_{m\in BM_u}P_{u,m}^{A(t)} + \sum_{o\in BO_u}P_{u,o}^{G(t)} - \sum_{n\in BN_u}P_{u,n}^{D(t)} \\
& \quad - \sum_{v\in\mathcal{L}} B_{uv}(\theta_u^{(t)} - \theta_v^{(t)}) = 0,\ \forall u,t\in\mathcal{L} && (7)\\
& -f_{uv}^{max} \le B_{uv}(\theta_u^{(t)} - \theta_v^{(t)}) \le f_{uv}^{max},\ \forall u,v,t\in\mathcal{L} && (8)\\
& 0 \le P_{u,m}^{A(t)} \le p_{u,m}^{A(t)},\ \forall m\in BM_u, \forall u,t\in\mathcal{L} && (9)\\
& 0 \le P_{u,o}^{G(t)} \le p_{l,o}^{G(t)},\ \forall o\in BO_u, \forall u,t\in\mathcal{L} && (10)\\
& 0 \le P_{u,n}^{D(t)} \le p_{l,n}^{D(t)},\ \forall n\in BN_u, \forall u,t\in\mathcal{L} && (11)\\
& \theta_{u=1} = 0, && (12)
\end{aligned}$$

0.1 目的関数

$$\begin{aligned}
&\sum_{t=1}^{48}\Bigg[-\sum_{u\in\mathcal{L}}\sum_{o\in BO_u}\lambda_{u,o}^{G(t)}P_{u,o}^{G(t)} + \sum_{u\in\mathcal{L}}\sum_{n\in BN_u}\lambda_{u,n}^{D(t)}P_{u,n}^{D(t)} - \sum_{u,v\in\mathcal{L}}\rho_{uv}^{min}f_{uv}^{max} + \sum_{u,v\in\mathcal{L}}\rho_{uv}^{max}f_{uv}^{max} \\
&-\sum_{u,v\in\mathcal{L}}\sum_{m\in BM_u}2\phi_{uv,m}^{Amax}p_{u,m}^{A(t)} - \sum_{u,v\in\mathcal{L}}\sum_{o\in BO_u}\phi_{uv,o}^{Gmax}p_{u,o}^{G(t)} - \sum_{u,v\in\mathcal{L}}\sum_{n\in BN_u}\phi_{uv,n}^{Dmax}p_{u,n}^{D(t)} - \sum_{u,v\in\mathcal{L}}\sum_{i\in\mathcal{S}_u}C_{u,i}^{DR(t)}P_{u,i(\omega)}^{DR(t)}\Bigg] \quad \text{(OBJ)}
\end{aligned}$$

0.2 不等式制約条件

$$\begin{aligned}
-P_{u,m}^{A(t)} &\le 0 && \forall u,t\in\mathcal{L}, \forall m\in BM_u && \text{(m-1)}\\
P_{u,m}^{A(t)} &\le p_{u,m}^{A(t)} && \forall u,t\in\mathcal{L}, \forall m\in BM_u && \text{(m-2)}\\
-\phi_{u,m}^{Amin} &\le 0 && \forall u,t\in\mathcal{L}, \forall n\in BM_u && \text{(m-3)}\\
-\phi_{u,m}^{Amax} &\le 0 && \forall u,t\in\mathcal{L}, \forall n\in BM_u && \text{(m-4)}\\
\phi_{u,m}^{Amin(t)} - Mu_{u,m}^{Amin(t)} &\le 0 && \forall u,t\in\mathcal{L}, \forall m\in BM_u && \text{(m-5)}\\
P_{u,m}^{A(t)} + Mu_{u,m}^{Amin(t)} &\le M && \forall u,t\in\mathcal{L}, \forall m\in BM_u && \text{(m-6)}\\
\phi_{u,m}^{Amax(t)} - Mu_{u,m}^{Amax(t)} &\le 0 && \forall u,t\in\mathcal{L}, \forall m\in BM_u && \text{(m-7)}\\
-P_{u,m}^{A(t)} + Mu_{u,m}^{Amax(t)} &\le M - p_{u,m}^{A(t)} && \forall u,t\in\mathcal{L}, \forall m\in BM_u && \text{(m-8)}
\end{aligned}$$

$$-P^{G(t)}_{u,o} \leq 0 \qquad \forall u,t \in \mathcal{L}, \forall o \in BO_u \tag{o-1}$$
$$P^{G(t)}_{l,o} \leq p^{G(t)}_{u,o} \qquad \forall u,t \in \mathcal{L}, \forall o \in BO_u \tag{o-2}$$
$$-\phi^{Gmin}_{u,o} \leq 0 \qquad \forall u,t \in \mathcal{L}, \forall o \in BO_u \tag{o-3}$$
$$-\phi^{Gmax}_{u,o} \leq 0 \qquad \forall u,t \in \mathcal{L}, \forall o \in BO_u \tag{o-4}$$
$$\phi^{Gmin(t)}_{u,o} - Mu^{Gmin(t)}_{u,o} \leq 0 \qquad \forall u,t \in \mathcal{L}, \forall o \in BO_u \tag{o-5}$$
$$P^{G(t)}_{u,o} + Mu^{Gmin(t)}_{u,o} \leq M \qquad \forall u,t \in \mathcal{L}, \forall o \in BO_u \tag{o-6}$$
$$\phi^{Gmax(t)}_{u,o} - Mu^{Gmax(t)}_{u,o} \leq 0 \qquad \forall u,t \in \mathcal{L}, \forall o \in BO_u \tag{o-7}$$
$$-P^{G(t)}_{l,o} + Mu^{Gmax(t)}_{u,o} \leq M - p^{G(t)}_{u,o} \qquad \forall u,t \in \mathcal{L}, \forall o \in BO_u \tag{o-8}$$

$$-P^{D(t)}_{u,n} \leq 0 \qquad \forall u,t \in \mathcal{L}, \forall n \in BN_u \tag{n-1}$$
$$P^{D(t)}_{u,n} \leq p^{D(t)}_{u,n} \qquad \forall u,t \in \mathcal{L}, \forall n \in BN_u \tag{n-2}$$
$$-\phi^{Dmin}_{u,n} \leq 0 \qquad \forall u,t \in \mathcal{L}, \forall n \in BN_u \tag{n-3}$$
$$-\phi^{Dmax}_{u,n} \leq 0 \qquad \forall u,t \in \mathcal{L}, \forall n \in BN_u \tag{n-4}$$
$$\phi^{Dmin(t)}_{u,n} - Mu^{Dmin(t)}_{u,n} \leq 0 \qquad \forall u,t \in \mathcal{L}, \forall n \in BN_u \tag{n-5}$$
$$P^{D(t)}_{u,n} + Mu^{Dmin(t)}_{u,n} \leq M \qquad \forall u,t \in \mathcal{L}, \forall n \in BN_u \tag{n-6}$$
$$\phi^{Dmax(t)}_{u,n} - Mu^{Dmax(t)}_{u,n} \leq 0 \qquad \forall u,t \in \mathcal{L}, \forall n \in BN_u \tag{n-7}$$
$$-P^{D(t)}_{u,n} + Mu^{Dmax(t)}_{l,n} \leq M - p^{D(t)}_{u,n} \qquad \forall n,t \in BN_u \tag{n-8}$$

$$-\rho^{min}_{uv} \leq 0 \qquad \forall u,v \in \mathcal{L} \tag{rho-1}$$
$$-\rho^{max}_{uv} \leq 0 \qquad \forall u,v \in \mathcal{L} \tag{rho-2}$$
$$\rho^{min}_{uv} - Mu^{min}_{uv} \leq 0 \qquad \forall u,v \in \mathcal{L} \tag{rho-3}$$
$$\rho^{max}_{uv} - Mu^{max}_{uv} \leq 0 \qquad \forall u,v \in \mathcal{L} \tag{rho-4}$$
$$B_{uv}(\theta^{(t)}_u - \theta^{(t)}_v) \leq f^{max}_{uv} \qquad \forall u,v \in \mathcal{L} \tag{rho-5}$$
$$-B_{uv}(\theta^{(t)}_u - \theta^{(t)}_v) \leq f^{max}_{uv} \qquad \forall u,v \in \mathcal{L} \tag{rho-6}$$
$$B_{uv}(\theta^{(t)}_u - \theta^{(t)}_v) + Mu^{min(t)}_{uv} \leq M - f^{max}_{uv} \qquad \forall u,v \in \mathcal{L} \tag{rho-7}$$
$$-B_{uv}(\theta^{(t)}_u - \theta^{(t)}_v) + Mu^{max(t)}_{uv} \leq M - f^{max}_{uv} \qquad \forall u,v \in \mathcal{L} \tag{rho-8}$$

$$-\lambda^{A(t)}_{u,m} \leq 0 \qquad \forall u,t \in \mathcal{L}, \forall m \in BM_u \tag{lambdaA}$$

$$-P^{DR(t)}_{u,i(\omega)} \leq 0 \qquad \forall u,t \in \mathcal{L},\ \forall i \in \mathcal{S}_u, \forall \omega \in \Omega \tag{PDR-1}$$
$$P^{DR(t)}_{u,i(\omega)} \leq \overline{P^{DR(t)}_{ru,i(\omega)}} \qquad \forall u,t \in \mathcal{L},\ \forall i \in \mathcal{S}_u, \forall \omega \in \Omega \tag{PDR-2}$$

$$-P^{(t)Bal+}_{u(\omega)} \leq 0 \qquad \forall u,t \in \mathcal{L}, \forall \omega \in \Omega \tag{ppv-1}$$
$$-P^{(t)Bal-}_{u(\omega)} \leq 0 \qquad \forall u,t \in \mathcal{L}, \forall \omega \in \Omega \tag{ppv-2}$$

0.3 等式制約

$$-\sum_{m\in BM_u} P_{u,m}^{A(t)} + \sum_{i\in \mathcal{S}_u} P_{u,i}^{DR(t)} - P_{u(\omega)}^{(t)Bal+} + P_{u(\omega)}^{(t)Bal-} = 0 \qquad \forall u,t \in \mathcal{L},\ \forall \omega \in \Omega \qquad \text{(eq-1)}$$

$$\sum_{m\in BM_u} P_{u,m}^{A(t)} + \sum_{o\in BO_u} P_{u,o}^{G(t)} - \sum_{n\in BN_u} P_{u,n}^{D(t)} - \sum_{v\in \mathcal{L}} B_{uv}(\theta_u^{(t)} - \theta_v^{(t)}) = 0 \qquad \forall u,t \in \mathcal{L} \qquad \text{(eq-2)}$$

$$\theta_{u=1} = 0 \qquad \text{(eq-3)}$$

$$\lambda_{u,m}^{A(t)} - \phi_{u,m}^{Amin(t)} + \phi_{u,m}^{Amax(t)} + \alpha_u^{(t)} = 0 \qquad \forall u,t \in \mathcal{L}, \forall m \in BM_u \qquad \text{(eq-4)}$$

$$\lambda_{u,o}^{G(t)} - \phi_{u,o}^{Gmin(t)} + \phi_{u,o}^{Gmax(t)} + \alpha_u^{(t)} = 0 \qquad \forall u,t \in \mathcal{L}, \forall o \in BO_u \qquad \text{(eq-5)}$$

$$\lambda_{u,n}^{D(t)} - \phi_{u,n}^{Dmin(t)} + \phi_{u,n}^{Dmax(t)} - \alpha_u^{(t)} = 0 \qquad \forall u,t \in \mathcal{L}, \forall n \in BN_u \qquad \text{(eq-6)}$$

$$B_{uv}(-\alpha_u^{(t)} - \rho_{uv}^{min(t)} + \rho_{uv}^{max(t)} - \rho_{uv}^{min(t)} + \rho_{uv}^{max(t)}) + (\gamma)_{u=1} = 0 \qquad \forall u,t \in \mathcal{L} \qquad \text{(eq-7)}$$