0.1 Main algorithm

Algorithm 1: main algorithm

Input: Demand matrix DM

Output: Routing ϕ_{best} (Fraction of demand)

```
Initialization : D = {DM}, DM_worst = 0;
// D is the set of demand matrix
while not meet the cutoff condition do
    D = D ∪ DM_worst;
    Find the best routing φ of D; // The First model
    φ_best = φ;
    Find the worst demand matrix DM_worst of φ_best // The second model
end
return φ_best
```

0.2 Original model in the paper

$$
\begin{aligned}
&\min \alpha \\
&\qquad \phi \text{ is a PD routing} \\
&\qquad \forall \text{ edges } e = (u, v) \\
&\qquad \forall \text{ DMs D} \in D \text{ with } OPTU(D) = r : \\
&\qquad \sum_{(s,t)} \frac{d_{st} f_{st}(u) \phi_t(e)}{c(e)} \leq \alpha r
\end{aligned} \tag{1}
$$

$$
OPTU(D) = \min_{\phi | \phi \text{ is a PD routing}} MxLU(\phi, D) \tag{2}
$$

0.3 Model 1 : The first model (unchanged)

`Find the best routing` ϕ `of the given set of demand matrix to minimize maximum link ultilization`

$\min \alpha$ (Minimize maximum link ultilization)

$$
\begin{aligned}
&\sum_{e=(v,u)\in E} \phi_{st}(e) - f^i_{st}(u) = \begin{cases} 1 & \text{if } u = s \\ -1 & \text{if } u = t \\ 0 & \text{others} \end{cases} \\
&, \forall (s,t) \in V \times V, 1 \le i \le |D|, \forall u \in V && \text{(Flow conservation)} \\
&\sum_{(s,t)} \frac{d^i_{st} f^i_{st}(u) \phi_{st}(e)}{c(e)} \le \alpha \ , \ \forall e \in E, 1 \le i \le |D| && \text{(Link capacity constraint)} \\
&0 \le \phi_{st}(e) \le 1 \ , \forall e \in E && \text{(Decision variable constraint)} \\
&0 \le \alpha \le 1 && \text{(Decision variable constraint)}
\end{aligned} \tag{3}
$$

0.4 Model 1 v2.1.0 : The first model, adding constraint $\frac{\sum_{s\in V, s\neq t} d^i_{st}\phi_{st}(e)}{\sum_{s\in V, s\neq t} d^i_{st}} = \phi_t(e)$

`Find the best routing` ϕ `of the given set of demand matrix to minimize maximum link ultilization`

$\min \alpha$ (Minimize maximum link ultilization)

$$\sum_{e=(v,u)\in E} \phi_{st}(e) - f^i_{st}(u) = \begin{cases} 1 & \text{if } u = s \\ -1 & \text{if } u = t \\ 0 & \text{others} \end{cases}$$

$$, \forall (s,t) \in V \times V, 1 \leq i \leq |D|, \forall u \in V \qquad \text{(Flow conservation)}$$

$$\sum_{(s,t)} \frac{d^i_{st} f^i_{st}(u)\phi_{st}(e)}{c(e)} \leq \alpha \ , \ \forall e \in E, 1 \leq i \leq |D| \qquad \text{(Link capacity constraint)}$$

$$0 \leq \phi_{st}(e) \leq 1 \ , \forall e \in E \qquad \text{(Decision variable constraint)}$$

$$0 \leq \alpha \leq 1 \qquad \text{(Decision variable constraint)}$$

$$\frac{\sum_{s\in V, s\neq t} d^i_{st}\phi_{st}(e)}{\sum_{s\in V, s\neq t} d^i_{st}} = \phi_t(e), \ \forall t \in V, 1 \leq i \leq |D| \qquad \text{(Decision variable constraint)} \tag{4}$$

0.5 Model 2 : The second model (unchanged)

`Find the worst demand matrix with given routing` ϕ `to maximize maximum link ultilization`

$\max \rho$ (Maximize minimum link ultilization)

$$\sum_{e=(v,u)\in E} \phi_{st}(e) - f_{st}(u) = \begin{cases} 1 & \text{if } u = s \\ -1 & \text{if } u = t \ , \forall s,t,u \in V \\ 0 & \text{others} \end{cases} \qquad \text{(Flow conservation)}$$

$$\rho \leq \sum_{(s,t)} \frac{d_{st} f_{st}(u)\phi_{st}(e)}{c(e)} \leq 1 \qquad \text{(Link capacity constraint)}$$

$$0 \leq \rho \leq 1 \qquad \text{(Decision variable constraint)} \tag{5}$$

0.6 Model 2 v2.1.0 : The second model, adding constraint $\frac{\sum_{s\in V, s\neq t} d^i_{st}\phi_{st}(e)}{\sum_{s\in V, s\neq t} d^i_{st}} = \phi_t(e)$

`Find the worst demand matrix with given routing` ϕ `to maximize maximum link ultilization`

$\max \rho$ (Maximize minimum link ultilization)

$$
\begin{aligned}
&\sum_{e=(v,u)\in E} \phi_{st}(e) - f_{st}(u) = \begin{cases} 1 & \text{if } u = s \\ -1 & \text{if } u = t \\ 0 & \text{others} \end{cases}, \forall s,t,u \in V && \text{(Flow conservation)} \\
&\rho \leq \sum_{(s,t)} \frac{d_{st} f_{st}(u) \phi_{st}(e)}{c(e)} \leq 1 && \text{(Link capacity constraint)} \\
&0 \leq \rho \leq 1 && \text{(Decision variable constraint)} \\
&\frac{\sum_{s\in V, s\neq t} d^i_{st}\phi_{st}(e)}{\sum_{s\in V, s\neq t} d^i_{st}} = \phi_t(e),\ \forall t \in V, 1 \leq i \leq |D|, e \in E && \text{(Decision variable constraint)}
\end{aligned}
\tag{6}
$$