0.1 Main algorithm

Algorithm 1: main algorithm

Input: Demand matrix DM

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

```
Initialization : DM_worst = ∅;
while not meet the cutoff condition do
    DM = DM + DM_worst;
    Find the best routing φ of DM; // 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

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

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

0.3 Model 1 : The first model

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

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

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

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

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

$$0 \leq \alpha \leq 1 \quad \text{(Decision variable constraint)} \tag{3}$$

0.4 Model 2 : The second model : Demand matrix has no constrainted

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

$\max \alpha$ (Maximize maximum link ultilization)

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

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

$$0 \leq \alpha \leq 1 \quad \text{(Decision variable constraint)} \tag{4}$$

0.5 Model 2 : The second model : Demand matrix must in a set D

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

$\max \alpha$ (Maximize maximum link ultilization)

$$
\begin{aligned}
&\sum_{e=(v,u)\in E} \phi_{st}(e) - f_{st}(u) = \begin{cases} 1 & \text{if } u = s \\ -1 & \text{if } u = t \\ 0 & \text{others} \end{cases}, \forall (s,t) \in D, \forall u \in V && \text{(Flow conservation)} \\
&\sum_{(s,t)} \frac{d_{st} f_{st}(u) \phi_{st}(e)}{c(e)} \le \alpha && \text{(Link capacity constraint)} \\
&\text{DM} \in D && \text{(Decision variable constraint)} \\
&0 \le \alpha \le 1 && \text{(Decision variable constraint)}
\end{aligned}
\tag{5}
$$