0.1 Main algorithm

Algorithm 1: main algorithm

Input: Demand matrix DM

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

Initialization : $D = \{\text{DM}\}$, $\text{DM}_{worst} = 0$;
`// ` D ` is the set of demand matrix`
while *not meet the cutoff condition* **do**
  $D = D \cup \text{DM}_{worst}$;
  Find the best routing ϕ of D; `// The First model`
  $\phi_{best} = \phi$;
  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 v2.1.1 : The first model, replacing $\phi_t(e)$ with $\phi_{st}(e)$

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

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

$$
\begin{aligned}
&\sum_{e=(u,v)\in E} \sum_{(s,t)} d^i_{st} f^i_{st}(v) \phi_t(e) - \sum_{(s,t)} d^i_{st} f^i_{st}(u) \qquad = \begin{cases} d_{st} & \text{if } u = s \\ -\sum_{(s,t)} d_{st} & \text{if } u = t \\ 0 & \text{others} \end{cases} \\
&, \forall (s,t) \in V \times V && \text{(Flow conservation)} \\
&\sum_{(s,t)} \frac{d^i_{st} f^i_{st}(u) \phi_t(e)}{c(e)} \le \alpha \ , \ \forall e \in E, 1 \le i \le |D| && \text{(Link capacity constraint)} \\
&0 \le \phi_t(e) \le 1 \ , \forall e \in E && \text{(Decision variable constraint)} \\
&0 \le \alpha \le 1 && \text{(Decision variable constraint)}
\end{aligned} \tag{4}
$$

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)

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

0.6 Model 2 v2.1.1 : The second model, replacing $\phi_t(e)$ with $\phi_{st}(e)$

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

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

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