Model : Oblivious routing

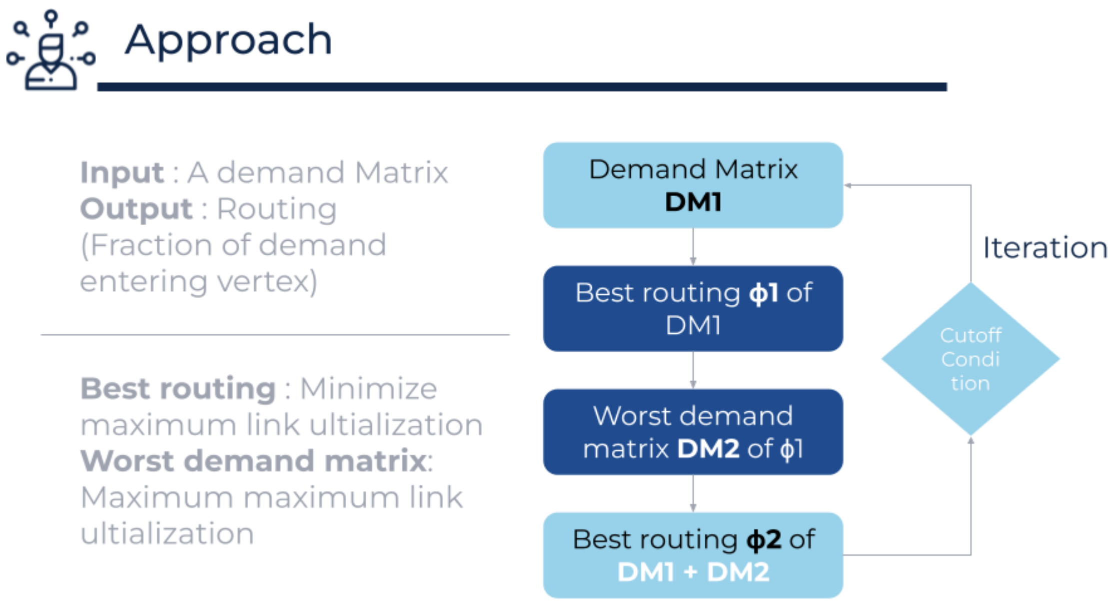
Tags	112-2 Oblivious Routing
Datum	@11. Februar 2024
Präsentation	https://docs.google.com/presentation/d/1RmGI7sELMFbk2IOxzNBs6EziNTCBfE1dtSw2Sp2Es1o/edit#slic
Status	Es kann geändert werden

Der Thikung von dem Lehrer

Input : Given a Demand Matrix DM_1

Output : Routing ϕ (Fraction of demand entering vertex)

1. Find the best routing ϕ_1 of DM_1
2. Find the worst demand matrix DM_2 of the routing ϕ_1
3. Find the best routing ϕ_2 of $\mathrm{DM}_1 + \mathrm{DM}_2$
4. Iteration until it meet the cutoff condition



Pseudo code

Algorithm 1: main algorithm

Input: Demand matrix DM

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

Initialization : $\mathrm{DM}_{worst} = \emptyset$;
while *not meet the cutoff condition* **do**
    $\mathrm{DM} = \mathrm{DM} + \mathrm{DM}_{worst}$;
    Find the best routing ϕ of DM; `// The First model`
    $\phi_{best} = \phi$;
    Find the worst demand matrix DM_{worst} of ϕ_{best} `// The second model`
end
return ϕ_{best}

Finden Sie größe Routing ϕ

Finding the link weight and traffic splitting ratio to minimize the maximum link ultilization

The first model

Indicate

DM	Demand matrix
e=(u,v)∈E	Edges form vertex u to vertex v
d_{st}	Demand form s to t
f_{st}(u)	Fraction of demand entering vertex u
c_e	Link capacity

Variable

α	The maximum link ultilization of the demand matrix DM
ϕ_{st}(e)	Routing fraction for edge e=(u, v)

Given demand matrix DM, find the fraction of demands that minimizing the maximum link ultilization.

Indicate

DM	Demand matrix
$e=(u,v)\in E$	Edges
d_{st}	Demand from s to t
$f_{st}(u)$	Fraction of demand entering vertex u
c_e	Link capacity

Variable

α The maximum link ultilization of the demand matrix DM

$\phi_{st}(e)$ Routing fraction for edge $e=(u,v)$

Objective function

Minimize the maximum link ultilization α

$$\min \alpha$$

Constraints

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

Model : Demand matrix has no constrainted

$$\min \alpha \text{ (Minimize maximum link ultilization)}$$

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

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

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

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

$$\min \alpha \text{ (Minimize maximum link ultilization)}$$

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

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

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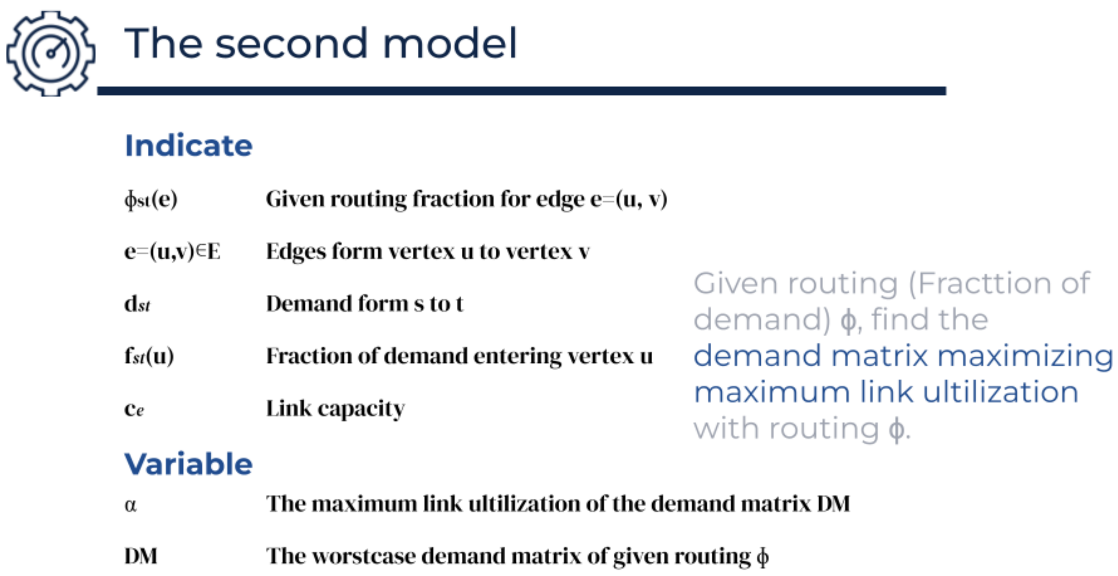
$$0 \leq \alpha \leq 1 \qquad \text{(Decision variable constraint)}$$

Find the worst demand matrix of routing ϕ

Find the demand matrix maximizing the maximum link ultilization with given routing ϕ



Indicate

$\phi_{st}(e)$	Given routing
$e = (u, v) \in E$	Edges
d_{st}	Demand from s to t
$f_{st}(u)$	Fraction of demand entering vertex u

c_e	Link capacity

Variable

DM The worstcase demand matrix of given routing ϕ

α The maximum link ultilization of the demand matrix DM

Objective function

Maximize the maximum link ultilization α

$$\max \alpha$$

Constraints

Demand matrix is unconstrained

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

Demand matrix must in a set *D*

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

Model

Demand matrix is unconstrained

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

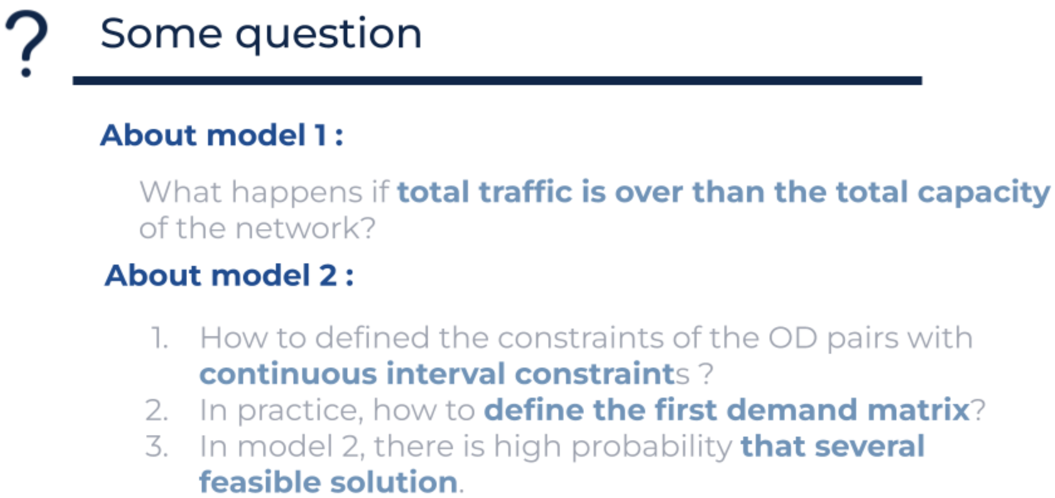
$$\begin{aligned} & \max \alpha \text{ (Maximize maximum link ultilization)} \\ & \sum_{e=(v,u)\in E} \phi_{st}(e) - f_{st}(u) = \begin{cases} 1 & \text{if } u = s \\ -1 & \text{if } u = t \\ 0 & \text{others} \end{cases}, \forall (s,t) \in D, \forall u \in V && \text{(Flow conservation)} \\ & \sum_{(s,t)}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

Demand matrix must in a set D

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

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

Etwas Fragen



Über Modell Eins

What happens if total traffic is over than the total capacity of the network?

Antwort

Über Modell Zwei

1. How to defined the constraints of the OD pairs with continuous interval constraints ?

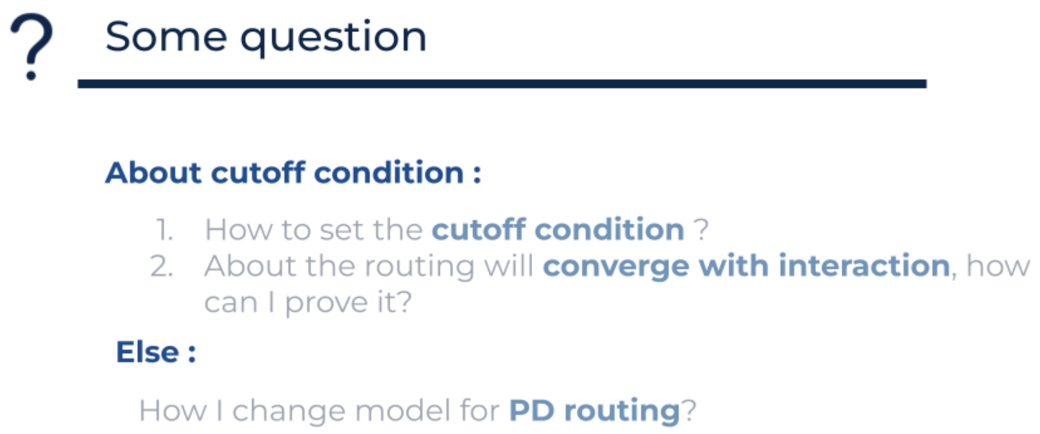
Antwort

2. In practice, how to define the first demand matrix?

Antwort

3. In model 2, there is high probability that several feasible solution.

Antwort



Über die Abschaltbedingung

1. How to set the **cutoff condition** ?

Antwort

2. About the routing will **converge with interaction**, how can I prove it?

Antwort

Andere

How I change model for **PD routing**?

Antwort