

برنامه ریزی حمل و نقل

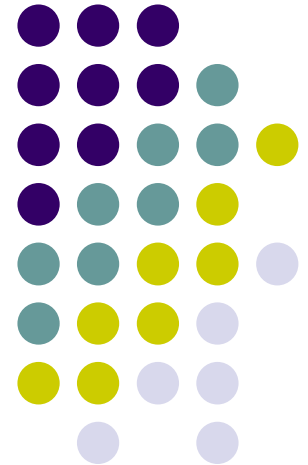
وزارت علوم، تحقیقات و فناوری



دانشگاه سوره

تخصیص ترافیک

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Traffic Assignment

► Overview

➤ **Concept:** The process of allocating of trip interchanges to the specified transportation system



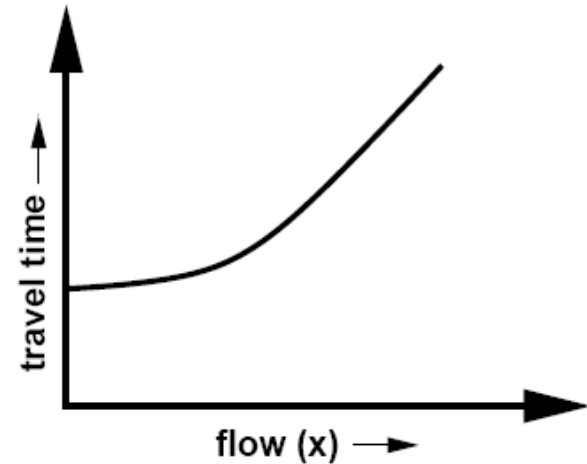
➤ **The major aims of the traffic assignment process:**

- 1. To estimate the volume of traffic on the links of the network and obtain aggregate network measures.
- 2. To estimate inter zonal travel cost.
- 3. To analyze the travel pattern of each origin to destination(O-D) pair.
- 4. To identify congested links and to collect traffic data useful for the design of future junctions.

Traffic Assignment

▶ Link cost function

➤ As the flow increases towards the capacity of the stream, the average stream speed reduces from the free flow speed to the maximum flow speed



➤ The relation between the link flow and link impedance is called the link cost function:

$$t = t_0 \left[1 + \alpha \left(\frac{x}{k} \right)^\beta \right]$$

Traffic Assignment

- ▶ **Traffic assignment models :**
 - **All-or-nothing assignment (AON)**
 - **User equilibrium assignment (UE)**
 - **System optimum assignment (SO)**
 - **Incremental assignment**
 - **Capacity restraint assignment**
 - **Stochastic user equilibrium assignment (SUE)**
 - **...**

Traffic Assignment

- ▶ **All-or-nothing assignment (AON)**
 - Ignore adequate capacity or heavy congestion and multiple paths
 - Ignore the fact that link travel time is a function of link volume

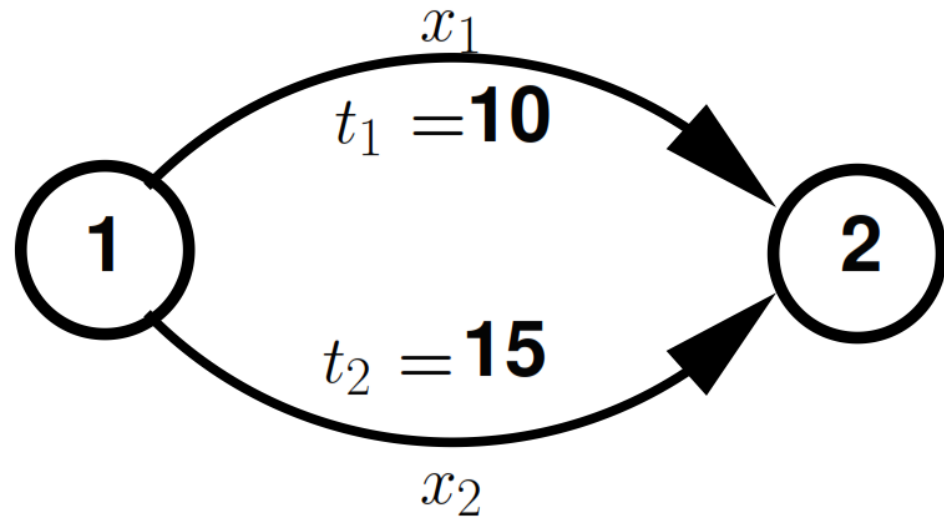


Traffic Assignment

▶ All-or-nothing assignment (AON)

➤ Example:

$$q_{12} = 12$$



$$X_1=? \quad \& \quad X_2=?$$

Traffic Assignment

▶ User Equilibrium Assignment (UE):

- ▶ Based on Wardrop's first principle: no driver can unilaterally reduce his/her travel costs by shifting to another route.

$$f_k(C_k - u) = 0 : \forall k$$

$$C_k - u \geq 0 : \forall k$$

$$\text{If } C_k = u \Rightarrow f_k \geq 0$$

$$\text{If } C_k > u \Rightarrow f_k = 0$$

Traffic Assignment

▶ User Equilibrium Assignment (UE)

▶ Assumptions in User Equilibrium

Assignment

1. The user has perfect knowledge of the path cost.
2. Travel time on a given link is a function of the flow on that link only.
3. Travel time functions are positive and increasing.

$$\text{Minimize } Z = \sum_a \int_0^{x_a} t_a(x_a) dx,$$

$$\text{subject to } \sum_k f_k^{rs} = q_{rs} \quad : \forall r, s$$

$$x_a = \sum_r \sum_s \sum_k \delta_{a,k}^{rs} f_k^{rs} \quad : \forall a$$

$$f_k^{rs} \geq 0 \quad : \forall k, r, s$$

$$x_a \geq 0 \quad : a \in A$$

$$\delta_{a,k}^{r,s} = \begin{cases} 1 & \text{if link } a \text{ belongs to path } k, \\ 0 & \text{otherwise} \end{cases}$$

Traffic Assignment

▶ User Equilibrium Assignment (UE)

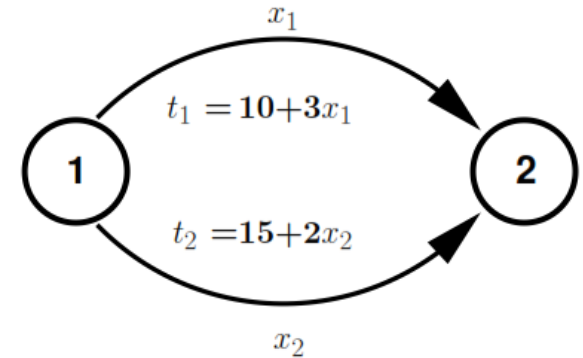
▶ Example:

$$\begin{aligned} \min Z(x) &= \int_0^{x_1} 10 + 3x_1 dx_1 + \int_0^{x_2} 15 + 2x_2 dx_2 \\ &= 10x_1 + \frac{3x_1^2}{2} + 15x_2 + \frac{2x_2^2}{2} \end{aligned}$$

$$q_{12} = 12 \implies x_1 + x_2 = 12 \implies x_2 = 12 - x_1$$

$$\min Z(x) = 10x_1 + \frac{3x_1^2}{2} + 15(12 - x_1) + \frac{2(12 - x_1)^2}{2}$$

$$\mathbf{x_1=5.8 \quad \& \quad x_2=6.2}$$



Traffic Assignment

▶ System Optimum Assignment (SO)

- Based on Wardrop's second principle: drivers cooperate with one another in order to minimize total system travel time.

$$\text{Minimize } Z = \sum_a x_a t_a(x_a)$$

Subject
to

$$\sum_k f_k^{rs} = q_{rs} \quad : \forall r, s$$
$$x_a = \sum_r \sum_s \sum_k \delta_{a,k}^{rs} f_k^{rs} \quad : \forall a$$
$$f_k^{rs} \geq 0 \quad : \forall k, r, s$$
$$x_a \geq 0 \quad : a \in A$$

Traffic Assignment

▶ User Equilibrium Assignment (UE)

▶ Example:

$$\begin{aligned} \min Z(x) &= x_1 * (10 + 3x_1) + x_2 * (15 + 2x_2) \\ &= 10x_1 + 3x_1^2 + 15x_2 + 2x_2^2 \end{aligned}$$

$$q_{12} = 12 \implies x_1 + x_2 = 12 \implies x_2 = 12 - x_1$$

$$\min Z(x) == 10x_1 + 3x_1^2 + 15(12 - x_1) + 2(12 - x_1)^2$$

$$\mathbf{x_1=5.3 \quad \& \quad x_2=6.7}$$

