وزارت علوم، تحقیقات و فناوری

دانشگاه سوره

برنامه ریزی حمل و نقل

تخصیص ترافیک

http://mnooriamiri.professora.ir/

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.**

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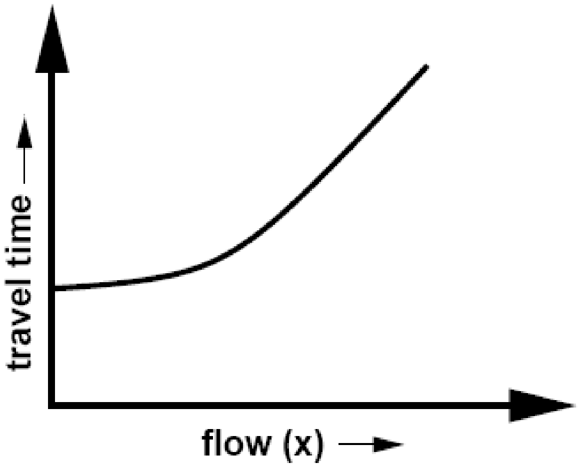
Traffic Assignment

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)**
  - **...**

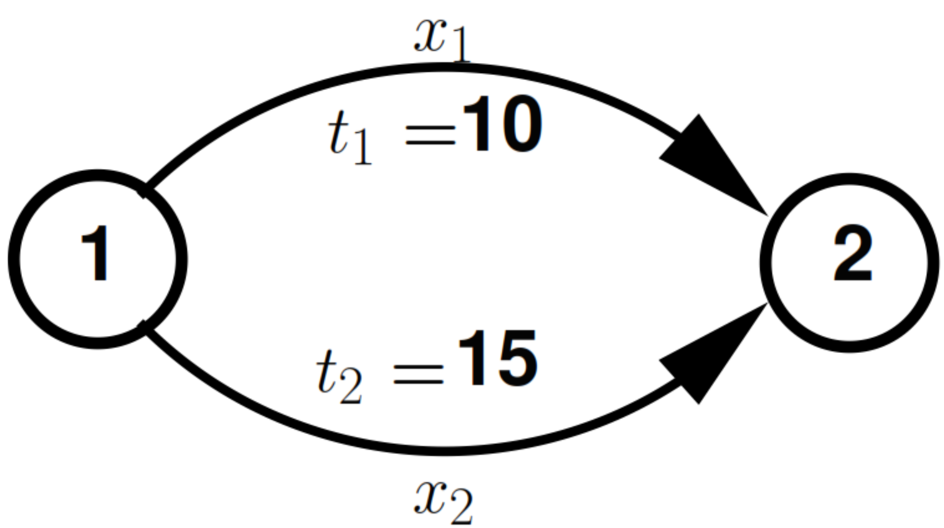
Traffic Assignment

- **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=? & X_2=?

Traffic Assignment

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- **User Equilibrium Assignment (UE):**
  - **Based on Wardrop's first principle: no driver can unilaterally reduce his/her travel costs by shifting to another route.**

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

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

$$If \quad C_k = u \Rightarrow \quad f_k \geq 0$$

$$If \quad C_k \rangle \mathrm{u} \Rightarrow \quad f_k = 0$$

Traffic Assignment

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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.

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

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

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

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

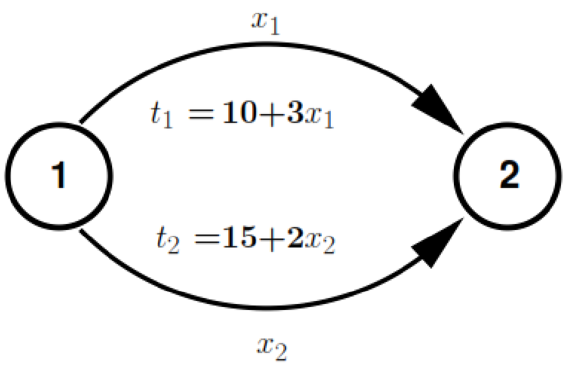
$$x_a \geq 0 \quad : a \in A$$

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

Traffic Assignment

- **User Equilibrium Assignment (UE)**

- **Example:**



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

$$= 10x_1 + \frac{3x_1^2}{2} + 15x_2 + \frac{2x_2^2}{2}$$

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

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

x1=5.8 & x2=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.**

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

Subject to

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

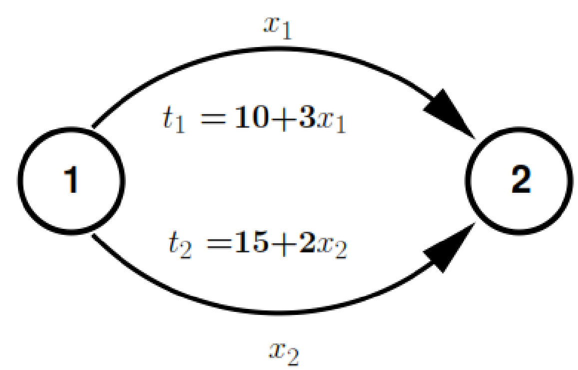
$$x_a = \sum_r \sum_s \sum_k \delta_{a,k}^{rs} f_k^{rs} \quad : \forall a$$

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

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

Traffic Assignment

- **User Equilibrium Assignment (UE)**
- **Example:**



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

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

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

x1=5.3 & x2=6.7