Traffic Assignment

John K. Abraham

CE 7630

Trip Assignment

- The final step in the modeling process
- Vehicle trips from one zone to another are assigned to specific travel routes between zones
- This assignment is done on the basis of minimum generalized cost of travel between each i,j pair of zones.
- This generalized cost as defined earlier is a linear combination of the link journey time and the link distance + fixed costs such as parking or tolls.
- When we are done we have an assigned network!
Traffic Assignment

Origin → Generation → Which path? → Cost → Attraction → Destination

- Time
- Number of connections

Highway Trip Assignment

In the case of travel by car, the time taken to complete a journey on a given link is a function of the characteristics of the link and the volume of traffic on it.

\[ J_i = f(L_{\text{Time}}, L_{\text{Distance}}, L_{\text{Flow Speed}}, L_{\text{Capacity Speed}}, L_{\text{Capacity}}, L_{\text{Flow Relationship}}) \]
All-or-Nothing Method

- Also called Shortest Path Method - assumes that travelers want to use the minimum impedance route between two points.
- All drivers will use the fastest route without regard to congestion caused by other vehicles.

### Speed Vs. Volume Curve

**Cost - Flow**

- $S_1$
- $S_2$

**Critical speed**

Travel Time

Flow $V$ vs. $V_{max}$

Wayne State University
Levels of Service for Road Transportation (Vehicle per Lane per Hour) 

\[ S = \frac{sf}{(1 + a(v/c)^b)} \]

- **A:** 600
- **B:** 960
- **C:** 1440
- **D:** 1824
- **E:** 2200

Where:

- \( T_Q = \) Travel time at traffic flow \( Q \)
- \( T_0 = \) "zero flow" travel time
  - = travel time at practical capacity \( \times 0.87 \)
- \( Q = \) traffic flow (veh/hr.)
- \( Q_{max} = \) practical capacity = 3/4 saturation flow
- \( \alpha, \beta = \) parameters
Assume that a link, 1 mile long, has a practical capacity = 40,000 veh/ day and a speed, at that capacity, of 40 mph.

Travel time at that volume = 1.5 min

Travel time $T_0 = 1.5 \times 0.87 = 1.31$ min

After the link is loaded, it is found that 60,000 veh/ day are assigned to it.

Assume that:

$$\alpha = 0.15 \quad \beta = 4$$

$$T = 1.31 \left[1 + 0.15 \left(\frac{60,000}{40,000}\right)^4\right] = 2.3 \text{ min}$$

This works out to 26mph at which 60,000 vehicles travel per day.
Minimum path with capacity restraints

1. based on finding that as the traffic flow increases, the speed decreases.
2. there is a relationship between impedance and flow for all types of highways.
3. assigns trips according to the impedances coded on the links of the network.
4. attempts to balance the assigned volume, the capacity of the facility and the related speed.

5. method loads the network and adjusts the assumed link speeds after each loading to reflect the volume/capacity restraints.
6. loadings and adjustments are done incrementally until a balance is obtained between speed, volume and capacity.
7. optimal solution is usually obtained after 3 or 4 adjustments.
Using Damping Factors to Control "Flip Flop"

- BY incorporating a damping factor you don’t let the change in travel time between each iteration change so quickly (flip flop)
- If the factor is, D = .25, then...

Instead of travel time changing from 7 to 12 minutes (change = 5), multiply change by .25...

\[ 5 \times 0.25 = 1.25, \]

change travel time from 7 to 8.25 minutes.

Then, proceed to next iteration.

Usually use max. 10 iterations
Wardrop’s Rules

- Wardrop [1952] is credited with first identifying the two fundamental approaches to trip assignment:
  - System Optimization: Assign O-D flows to paths so as to minimize the total (average) system travel time.
  - User Equilibrium: Assign O-D flows so that no user of the system can unilaterally change routes and improve his/her travel time thereby.

User Equilibrium

- Each trip-maker chooses his/her route through the network which minimizes his/her individual travel time
- Equilibrium is achieved when every trip-maker is using the best route possible, given prevailing congestion levels
- This is an equilibrium, since no user can switch routes and improve his/her travel time, and so no user will switch voluntarily
Assignment not in equilibrium
Assignment in equilibrium

Total demand is 1000 trips from p to q

The problem is to assign trips to links in order to minimize total travel time and that the travel time on each link is the same.
The travel time functions for each link are given by:

\[ s_1(v_1) = 10\{1+0.15(v_1/200)^4\} \]
\[ s_2(v_2) = 20\{1+0.15(v_2/400)^4\} \]
\[ s_3(v_3) = 25\{1+0.15(v_3/300)^4\} \]

\[ \text{Min} \sum_i s_i(v_i) \]
\[ \text{s.t.} \]
\[ \sum_i v_i = 1000 \]
\[ s_i(v_i) = s_j(v_j) \quad \text{for each } i - j \text{ pair} \]
\[ v_i \geq 0 \]

Transit Assignment

- Transit network assignment usually is not a function of congestion
- Procedures typically used:
  - all-or-nothing
  - stochastic (multi-path)
- Must account for:
  - walk access/egress times
  - waiting times (function of headway)
  - Transfers
  - Feasible transfer points
  - Transfer times
Uses of Traffic Assignment

- As an analysis tool, model output can be used to analyze many things.
  - Proposed road improvements can be compared against existing and no-build scenarios.
  - Proposed general plans or plan amendments can be compared to the adopted general plan.
  - Alternative routes can be selected within a transportation corridor.
  - Traffic impacts due to site plans, zone changes, or just a change in current land use can also be analyzed.

All done??

- We must calibrate and validate the model
  - an attempt to duplicate travel for the year in which the survey data is available
  - each step in the 4-step modeling process is calibrated separately
  - the model must replicate the base year traffic counts to be validated
- Once validated, the model can be used to predict future travel patterns with a high degree of confidence
Results of the 4 step modeling process

- Reports and plots identifying traffic impacts on the overall circulation system and each street segment.

- Some of the outputs from the model include:
  - Daily and peak hour traffic volumes
  - Number of trips
  - Vehicle miles or distance traveled
  - Hours of delay caused by congestion
  - Travel time

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2025 RTP Projects
FY 2001-2005
2025 RTP Fiscal Analysis

$17 billion unmet needs

$24 billion investment

SEMCOG Slide

7,100 miles resurfaced, rebuilt

SEMCOG Slide
727 miles congested

425 miles widened
13 miles of new road