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TRIP ASSIGNMENT

Introduction to Transportation Planning

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INTRODUCTION

- Travelers try to find the best route that minimize the travel costs.
- From several alternative routes, traveler found a stable route pattern after several attempts.
- Up to each travelers can't search a better route to reach their destination, this condition is called as a Network Equilibrium

- In the route trip assignment, there are several inputs:
  1. OD (Origin – Destination Matrix),
  2. Road network: volume, length, width, etc
  3. Road Robustness
  4. Toll Road

- Each model has steps that must be done in sequence. The basic functions are:
  1. To Identify some routes that will be expected to be of interest by traveler, this route will be stored in a structure data that called by a tree. therefore, this step is called the tree formation steps.

  2. To load the origin destination matrix to road network with appropriate proportion which produced the volume of movement on each road in the road network.
  3. To search the convergence, some techniques follow a repetitive pattern from approach toward the solution.

- The result of traffic network assignment are:
  1. V/C ratio,
  2. Vehicle speed,
  3. Travel time
  4. Route chosen

ROUTE ASSIGNMENT METHOD

- The types of traffic assignment models are:
  1. *All or Nothing Assignment*
  2. *Stochastic Traffic Assignment*
  3. *Incremental Assignment*
  4. *User Equilibrium Assignment*
  5. *Capacity Restraint Assignment*

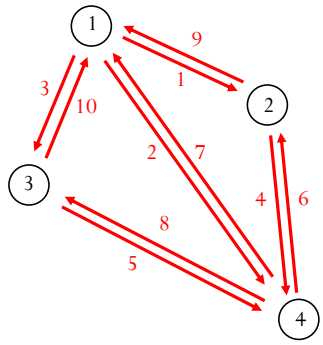
1. All or Nothing Assignment

This method is the simplest route choice model which assumes that:

- All the riders try to minimize the cost trip depend on the characteristic of the road network and estimate riders.
- All trips from origin zone (i) to destination zone (j) will follow the fastest route.
- The cost factor is fixed and not affected by the congestion factor

EXAMPLE 1

Road Network



Travel Time

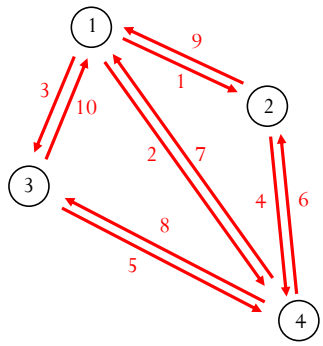
Link #	*ta*
1	5
2	15
3	6
4	8
5	7
6	8
7	15
8	7
9	5
10	6

OD Matrix

T_{14} = 150

T_{12} = 250

Question: Calculate the volume of traffic on roads no. 1 !



1 to 2

Route	Link	Cost
1	1	5
2	3, 5, 6	21
3	2, 6	23

1 to 4

Route	Link	Cost
1	2	15
2	1, 4	13
3	3, 5	13

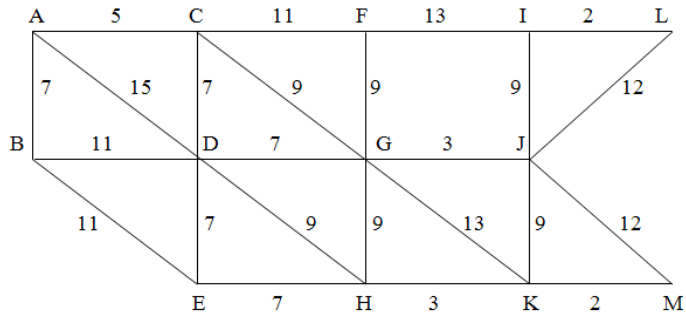
Answer:

T_{121} = 250

T_{142} = T_{143} = 150/2 = 75

EXAMPLE 2

A road network connect residential area: A and B with 2 shopping area: L and M. The travel time on each road section is shown in the figure below and expressed in minutes. All road segments are assumed have the 2 directions. All variables which are not mentioned above are considered to be zero (0).



Question:

a. Search the fastest route from origin A and B to destination L and M, how long the travel time?

b. From the survey results, at the peak hour on Saturday is known the amount of movements from A and B to L and M:

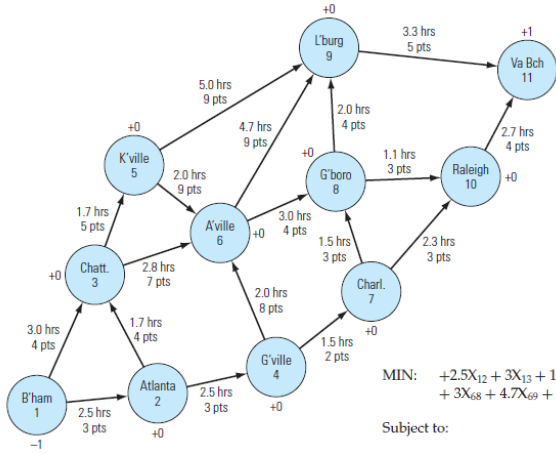
A – L : 600 vehicles

B – L : 300 vehicles

A – M : 400 vehicles

B – M : 400 vehicles

Calculate the amount of traffic flow on each road section in peak hour on Saturday! Use the all or nothing method!



Example for AON simulation with Excel

which the routes are selected?

MIN: $+2.5X_{12} + 3X_{13} + 1.7X_{23} + 2.5X_{24} + 1.7X_{35} + 2.8X_{36} + 2X_{46} + 1.5X_{47} + 2X_{56} + 5X_{59} + 3X_{68} + 4.7X_{69} + 1.5X_{78} + 2.3X_{7,10} + 2X_{89} + 1.1X_{8,10} + 3.3X_{9,11} + 2.7X_{10,11}$

Subject to:

$-X_{12} - X_{13}$	$= -1$	} flow constraint for node 1
$+X_{12} - X_{23} - X_{24}$	$= 0$	} flow constraint for node 2
$+X_{13} + X_{23} - X_{35} - X_{36}$	$= 0$	} flow constraint for node 3
$+X_{24} - X_{46} - X_{47}$	$= 0$	} flow constraint for node 4
$+X_{35} - X_{56} - X_{59}$	$= 0$	} flow constraint for node 5
$+X_{36} + X_{46} + X_{56} - X_{68} - X_{69}$	$= 0$	} flow constraint for node 6
$+X_{47} - X_{78} - X_{7,10}$	$= 0$	} flow constraint for node 7
$+X_{68} + X_{78} - X_{89} - X_{8,10}$	$= 0$	} flow constraint for node 8
$+X_{59} + X_{69} + X_{89} - X_{9,11}$	$= 0$	} flow constraint for node 9
$+X_{7,10} + X_{8,10} - X_{10,11}$	$= 0$	} flow constraint for node 10
$+X_{9,11} + X_{10,11}$	$= +1$	} flow constraint for node 11
$X_{ij} \geq 0$ for all i and j		} nonnegativity conditions

2. Stochastic Traffic Assignment

This model is more realistic because the currents spread to many routes by observing the tendency of every rider in choosing the route.

- This method assumes the traveler will takes the fastest route, but they are not sure about where the fastest route.
- The travel time for each route which is considered as the fastest route by traveler is produced with a selection of randomly which has an average actual travel time of the route.
- Only one route to be used between each pair of zones I and j. the sum of the traffic flows between of the zones I and j produced the level of randomness assignment.

3. Incremental Assignment

- This model is a process where the volume of traffic is added gradually
- In each step, the fixed amount of total demand is analyzed, based on the model of all or nothing.
- After each step, the travel time is recalculated based on these volumes. If there are a lot of additional demand, the traffic flow may be similar with *equilibrium assignment* model but this method doesn't produce a balance solution.
- As a result, there will be inconsistencies between these volumes and travel time which can cause errors in evaluation measures.

***Incremental Assignment* Algorithm**

Start

Iteration – 0

1. Determine the flow value = 0

Iteration Process

Iteration – 1

2. Determine the fraction load and the flow value (F)
3. Load the flow value (F) with *all or nothing* method
4. Calculate the new flow value on each routes (V) → $V^{n+1} = V^{n} + F$
5. Repeat step 3

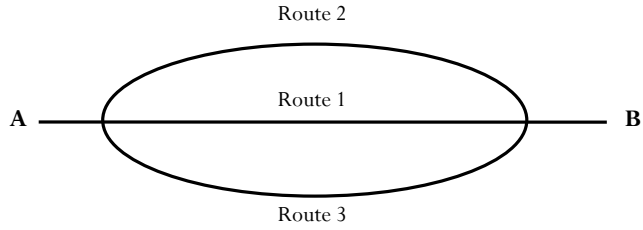
Iteration finished

Check →

$$\delta = \sum_{rute=1}^{n} \left[V_{rute} * \left(t_{rute} - t_{\min} \right) \right] \Big/ V_{total} * t_{\min}$$

EXAMPLE 3

- There are movements from A to B about 2000 vehicles. Calculate the traffic flow on each road section with uniform fraction assignment 25 % !



- Travel time on each route:

  Route 1 → t = 10 + 0,02 *traffic volume

  Route 2 → t = 15 + 0,005 * traffic volume

  Route 3 → t = 12,5 + 0, 015 * traffic volume

- Answer

  25 % x 2000 = 500 movement on each iteration and there are 4 iterations

Iteration	F	Route 1		Route 2		Route 3	
		Flow	Time	Flow	Time	Flow	Time
0	0	0	**10**	0	15	0	12,5
1	500	500	20	0	15	0	**12,5**
2	500	500	20	0	**15**	500	20
3	500	500	20	500	**17,5**	500	20
4	500	500	20	1000	**20**	500	20

convergence value = 500 (20-20) + 1000 (20-20) + 500(20-20) / (2000 x 20) = 0

traffic flow in route 1 = route 3 = 500 vehicles

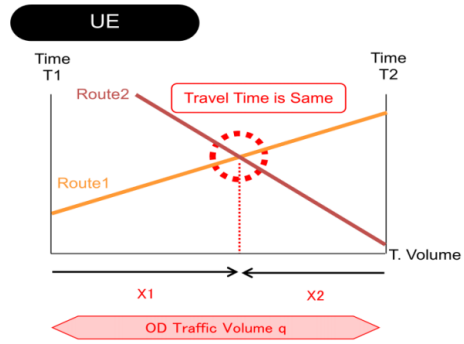
traffic flow in route 2 = 1000 vehicles

CONTOH 4

- Use problems in example 3, if used uniform fraction assignment 50%, how the amount of traffic flow in each route?

4. User Equilibrium Assignment

If the stochastic effects are ignored and the limit capacity become one of mechanisms of movement of the deployment proccess in a network and associate the movement function with a travel time is called by the principle of balance.



5. Capacity Restraint Assignment

There are 2 basic characteristics to the capacity limits model,

- Non-linear Relationship and
- Use volume – capacity ratio or v/c as a common factor

The underlying premise of capacity control model is that the travel time on any service related with the volume of traffic on this route. This is accordance with the level of service (LOS), which LOS related with low v/c and higher vehicle speed. The limit of capacity is LOS with E level as same as v/c =1

Delay Function in *Capacity Restraint Assignment*

- Delay function is useful in determining how much delay time (minute) that occurs as a result of traffic passing on a road section with a certain capacity.

- Equations used (BPR, 1964):

$$t_a = to_a [\, 1 + 0{,}15 \, (V_a / C_a)^4 \,]$$

ta : travel time on road section *a*
tO_a : travel time on road section *a* with FFS condition
V_a : Traffic flow on road section *a*
C_a : Capacity on road section *a*

Algoritma dalam *Capacity Restraint Assignment*

Start

1. Start with to_a
2. Choice the route with *all or nothing* method
3. Calculate the value of t_a
4. Calculate the new value of t_a ,is from 0,75 * $t_{a\ (on\ step\ 3)}$ + 0,25 * $to_{a\ (on\ step\ 1)}$

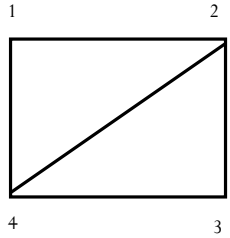
Iteration Process

5. Back to Step 2
6. Calculate with several iterations, then average the flow of traffic in each road

EXAMPLE 5

$T_{13} = 100$ vehicle/hour

$T_{24} = 100$ vehicle/hour



Link	Time (minute)	Capacity (Vehicle/hour)
1 – 2	15	100
2 – 3	10	100
1 – 4	10	100
3 – 4	5	100
2 – 4	20	100

Calculate the flow of traffic on each road with *capacity restraint* method!