Tutorial

TRANSPORT PLANNING AND MODELING

Using TFTP
(Teacher Friendly Transportation Program)

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WHAT IS MODEL ?

Ortusar and Willumsen, 1994,

" A simplified representation of a part of the real world – the system of interest – which concentrates on certain elements considered important for analysis form a particular point of view"

TRANSPORTATION MODELLING :

- Macro Simulation

  Evaluate traffic flow as a whole without consideration of the characteristics and features of individual vehicles in the traffic stream.

- Micro Simulation

  Model the individual vehicles in the traffic stream and consider the features and characteristics of the individual vehicles and use car following logic and algorithms to predict and model the movement of each vehicle in the traffic stream

MAIN PURPOSES :

- Modeling the existing condition
- Understanding the effects of a transport policy
- Forecasting

THEORY OF TRIPMAKING

- The **utility** of trip making is to combine activity on different locations
- But, a trip requires **sacrifice**: money-cost, time-cost, etc.
- People have to decide **to leave or to stay, to choose their destination, mode choice, and route**.
- From those, people choose the alternative that maximize the different between Utility and Sacrifice : **The Consumer Surplus**

- To make a trip, following decisions are needed:

  1. Which activity and when **(Production / Trip ends)**
  2. Where the activity should be done **(Distribution)**
  3. Which mode of transport should be used **(Mode Choice)**
  4. Which route should be chosen **(Route Choice)**

Several Tools of Transport Modeling

- TFTP
- SATURN
- CUBE
- EMME
- TRANPLAN
- JICA STRADA
- AIMSUN , etc.

TFTP

- TFTP = Teacher Friendly Transportation Program
- TFTP is developed to learn the calculation of:

  1. Traffic flows in road network
  2. Transit flows in public transportation network *(not explained in our tutorial)*

Advantages :

- User friendly
- 2D and 3D Assignment
- Complex algorithm for either car or public transport assignment

Disadvantages :

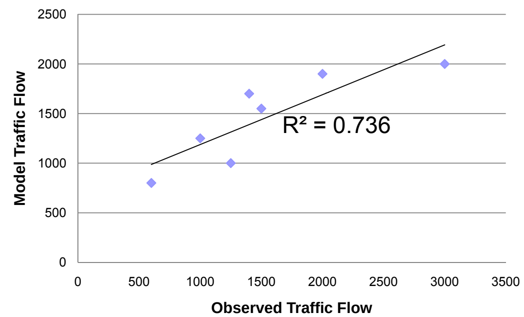
- 99 nodes
- Delay function is given
- Incompatible with GIS
- With O_i and D_j, Not T_{ij}

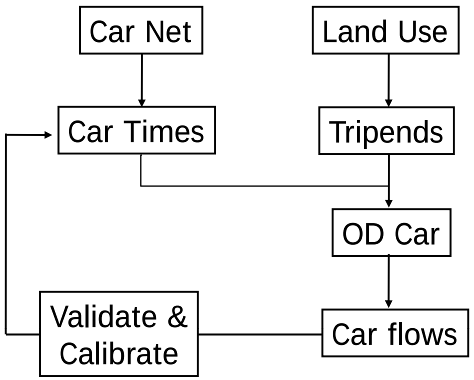
TFTP Calculation Steps for Unimode Car Model :

- **Car Network**
  - Input of the car network with speeds and capacities
  - It has the possibilities of toll roads, and 2 or 1 directed road
- **Land Use**
  - Input of jobs and worker residence by zone
- **Tripends**
  - Calculation of the number of trips departing from each origin zone and arriving in each destination zone

- **Car Times**
  - Determination of the route and generalized times between origin and destination zones
- **Car OD Matrix**
  - Calculation of the car trips between origin and destination zones: the OD matrix with single or double constraint options
- **Car Flows**
  - Determination of the traffic flows by assignment of OD matrix to car network
  - Available assignment methods are: All or Nothing Model, Stochastic Model, Equilibrium Model with Users Optimum and System Optimum, Stochastic Equilibrium Model

- **Validation and Calibration**
  - Re-estimation of the Car OD Matrix to fit surveyed traffic count and or travel speed (with note that the network is totally correct)





Model Structure of Unimodal Model in TFTP

It Should Be Pointed Out :

- **Area of study :**
  - outer boundary
  - inner boundary
- **Coordinate of node :**
  - dummy node
  - centroid node
- **Link characteristic :**
  - capacity in pcu / hour
  - free flow speed in kph
  - road characteristic: 1/2 way(s)

- **T_{ij} :**
  - internal – internal
  - external – external
  - internal – external
  - external – internal
- **Mode Choice :**

  OD Matrix for Car Users is defined separately with OD Matrix for Public Transport Users
- **Trip Assignment Type :**
  - 2D Assignment
  - 3D Assignment

TFTP 2D Assignment Methods :

- **All or Nothing Assignment**

  The implicit assumption is made that all driver have

  - complete knowledge about the travel time in the entire road system
  - no delay by congestion
  - they all chose the objective shortest route
  - the travel time does not change in time

  Equation :

$$v_a = \sum_i \sum_j \sum_r T_{ijr} . \delta_{ijr}^a$$

Pseudo Stochastic Assignment or Logit Assignment

Assumed is that the choice between 2 routes is given by logit model

Equation :

$$\Pr\left\{U_r < \min\left(U_r^*\right)\right\} = \frac{e^{-U_r}}{e^{-U_r} + \sum_r e^{-U_{r^*}}}$$

The assumption made are:

- Error term is Weibull distributed
- The route are stochastic independent

Stochastic Assignment

The implicit assumption is made that drivers:

- Are uncertain about the travel time in the entire road system
- Chose the route they think to the best. Because they have their own perceptions of driving time they choose the different routes
- Are not influenced by delay caused by traffic congestion

Equilibrium Assignment

The equilibrium assignment is applied to networks which have overloaded links.

Distinction can be made between:

1. User optimum
2. System optimum

User Optimum

The implicit assumption is made that all drivers have:

- Complete knowledge about the travel time in the entire road systems
- Delay by traffic congestion
- They all chose the objective shortest route

The delay on the links is determined by the delay function.

The delay is used to calculate the routes in the network which influence on route calculation

The delay used in TFTP refers to BPR 1964 :

$$Z_{qa} = Z_{min\ a} [1 + \alpha (V_a / C_a)^{\beta}]$$

Z_{qa} : time on the loaded link *a*

$Z_{min\ a}$: time on the unloaded link *a*

V_a : the link flow on link *a*

C_a : the link capacity of *a*

α : parameter, usually 0.15

β : parameter, usually 4

System Optimum

The objective is to minimize the total time in the network :

$$\text{Min}_{v_a} = \{ \sum_a (z_{v_a} . t_{v_a}) \}$$

- **Stochastic Equilibrium Assignment**
  - Combining the equilibrium and stochastic assignments.
  - The equilibrium assignment is applied to networks with overloaded link taken in account the uncertainty of the car drivers too

RUNNING TFTP - 97

STARTING THE PROGRAM

- Click **TFTP program**
- There are 2 options:

  - Press **F5** to Continue

  - Press **F10** for Program Information

- Entering to The Menu of TFTP
- Three menus:

  [1].. New session

  Creating a new file

  [2].. Restart

  Restarting an existing file, with similar file name

  [3].. Continue

  Continuing an existing file

- Press **1** → Choose new session
- Press **ENTER**

- Three performances of TFTP

  1. Car Assignment

     To assign car demand

  2. Public Transport Assignment

     To assign public transport demand

  3. Lectures & Research

FILE MANAGEMENT

- Choose **USER FILE** and press **ENTER**
- Several Menus:

  CHOOSE (Choosing our file already created)

  SAVE

  NEW (Creating a new file)

  RENAME

  ERASE

  EXIT (Exit from File Management)

- For trying and understanding what TFTP is and how it works, lets choose **NEW** and press **ENTER**
- Enter New Name: (for example) MZI
- Write MZI and press **ENTER**
- If your file name appears in the upper right corner, it is working
- Choose **EXIT** and Press **ENTER**

MODIFYING THE CAR NETWORK

- Choose **CAR NETWORK, LAND-USE**
- Press **ENTER**
- **Scale 1 cm = 0.5 km**, means that 1 cm in the model is equal to 0.5 km in the field
- Yellow line shows the length of 16 cm or equal to 8 km
- If your study area can be covered by that scale, you do not need to change the scale factor, and thus press **ENTER**

- For example, our study area has a horizontal line 30 km. So, it will be impossible to use that scale
- Determine: 1 cm in the model = 2 km in the field
- Write **2** and then press **ENTER**
- It shows that the maximum length for 16 cm in the model is equal to 32 km and is higher than 30 km
- If yes, press **ENTER**

Adding, replacing, and/or deleting nodes

- Press **R** to create a boundary line
- Press **ENTER**
- Determine the benchmark (0, 0)
- If yes, Press **C**
- Look, each movement to left-right = 0.8 km (x axis) and to up-down = 0.6 km (y axis)

+ to add a node

- to erase the last added node

? to relocate a node

It is useful if you want to change the node location.

For example, the coordinate of node #1 is incorrect and you realize after you have added the 95th node.

- You do need a foolish action by press **(–)** for 95 times
- Just do it:

1. **Press ?**
2. **Press 1** (according to your incorrect node)
3. **Press ENTER**
4. Choose the correct location and **press (+)**

- However, the incorrect still appear.
- To delete: **Press -**

The incorrect node and however the last node will be erased

- Again, create the last node (node #95)

To exit from **CAR NETWORK**:

- Press **ESCAPE**
- Choose **EXIT** and press **ENTER**

Correction: TFTP Scale Factor

If 1 cm = 0.5 km

Scale 1 : 0.5, not 1 : 50 as appeared in TFTP

What:

If 1 cm = 1 km

Scale 1 : 1, not 1 : 25

Exercise: Adding a node

Scale 1 : 1

# Node	X Axis	Y Axis
1	0	0
2	8	0
3	8	8
4	0	8

What if :

- Scenario 1 :

  There is no node #2

- Scenario 2 :

  Node #2 at 4, 0

Creating and specifying roads in the car network

- Choose **ROADS** and press **ENTER**
- Many choice of road types:
  - **TYPE A** : Cap.: 4000 pcu/hour, FFS : 100 kph, 2 ways
  - **TYPE B** : Cap.: 1400 pcu/hour, FFS : 70 kph, 2 ways
  - **TYPE C** : Cap.: 1600 pcu/hour, FFS : 40 kph, 2 ways
  - **TYPE D** : Cap.: 800 pcu/hour, FFS : 20 kph, 2 ways
  - **USERTYPE** : Special link can be defined by option

Please note:

TYPE A and **TYPE B** have an inverted capacity of each other

Exercise: drawing a link

#1 : 1 to 2 → Road: FFS 25 kph, Cap. 3500 pcu, 2 ways

#2 : 2 to 3 → Road: type A

#3 : 3 to 4 → Road: type D

#4 : 1 to 4 → Road: FFS 30 kph, Cap. 2000 pcu, 2 ways

#5 : 3 to 1 → Road: FFS 35 kph, Cap. 3100 pcu, 1 way

Note :

2 ways → 2 lines

1 way → 1 line

For Example: Drawing Link #5 (Node 3 to Node 1) FFS 35, Cap. 3100, 1 way

- Choose **USERTYPE**, press **ENTER**
- Choose **SPEED,** press **ENTER,** write **35** kph, press **ENTER**
- Choose **CAPACITY**, press **ENTER,** write **3100** pcu/h, press **ENTER**
- Choose **ONE/TWO WAY**, press **ENTER** : appear ONE way road
- If yes, choose **QUIT**, press **ENTER**
- Write node **3** and press **ENTER**, then write node **1** and press **ENTER.** Press **ENTER** once more to finish

Please draw all links within the network

Scenario:

What if Link #5 is not 1 way but 2 ways

Enlarging Part of The Network

- Choose **ZOOM**
- Use the cursor keys to move the frame
- Use **<+>** or **<->** to enlarge or reduce the frame
- Press **ENTER** to execute enlargement
- To retrieve the original picture, choose **ZOOM** again and press **ESC**

SPECIFYING LAND USE DATA

- Choose **LAND-USE** and press **ENTER**
- Appear: **Scale 1 : 10. Give other scale if wanted or (enter) to continue**

  If our scale is 1 : 10, press **ENTER**

  For example, our scale is 1 : 100, write **100** and press **ENTER**
- Appear: **Change scale <y/n>?**

  Write **n** and press **ENTER** to retrieve to the previous scale

  Write **y** and press **ENTER** to change scale

- Again, appear:

  Scale 1 : 100 Give other scale if wanted or (enter) to continue
- If the above scale is correct, press **ENTER**
- If want to change the scale, write the new one and back to previous steps

- Appear: **# working residents = # job (origin = destinations) in all zones (Y/N) ?**

  Write **Y** if within Zone A, The value of generation is equal to attraction

  Write **N** if otherwise

- Appear: **Answer <N> if the next zones will have NOT intrazonal trips ?**

  Write **Y** if there are intrazonal trips (from Zone A to Zone A)

  Write **N** if otherwise

Exercise: Inputting Trip Generation and Trip Attraction

- Node 1 and 3 are centroid nodes, otherwise are dummy nodes
- Node 1 generates 100 working residents (not trips) and attracts 150 jobs: there are 150 persons who is working within Node1 (not trips)
- Node 3 generates 200 working residents and attracts 50 jobs

- Write **1** in **Node # ?** and press **ENTER**
- Write **100** in **0 jobs (or origin) in zone 1 Change ?** and press **ENTER**
- Write **150** in **0 working residents (or origin) in zone 1 Change ?** and press **ENTER**
- Do the similar steps for Node 3
- Press **ENTER** in **Node # ?** if finish
- Press **ENTER** in **< enter > to continue ?** to quit

- Appear: **TOTAL EMPLOYMENT = 300 <> TOTAL WORKING POPULATION = 200**

  Balancing required (Y/N)?

Please note:

Total Employment = Jobs = Destination

Working Population = Working Residents = Origin

Write **N**, if using the previous-determined OD data

Write **Y**, if total employment = working population. It changes the previous-determined OD data to the new OD data in pursuing the equilibrium

For example, we use the previous-determined OD data, thus write **N** and press **ENTER**

Scenario :

What if Node #3 attracts 100 jobs and not 50 jobs?

- **ERASE** is used to erase links

For example, Link from Node 2 to 3 will be erased:

- Choose **ERASE** and press **ENTER**
- Write **2** and press **ENTER** in **Node ?**
- Write 3 and press **ENTER**
- Press **ENTER** to finish
- Again, press **ENTER** to quit

- **RESTART** is used to restore our modified network

  Just choose **RESTART** and press **ENTER**

- **EXIT** is used to back to the TFTP menu

  Appear : You have changed the network ….

  Write **Y**, to save our determined data

  Write **N**, to unsaved

For example :

- Choose **EXIT** and press **ENTER**
- Write **Y** and press **ENTER**
- Save our created network, give our file name: MZI, write **MZI** and press **ENTER**
- Appear : **Save of the original report files …**
- Write **N** and press **ENTER** to save file name for MZI

- Appear : **Generalized time = 0,25 * length + 0,75 * time**

  For example, use the above values in our iterative assignment, press **ENTER**

- Appear : **Do you want to see the network (Y/N) ?**

  Write **Y** if want to see the network

  Write **N** if otherwise

  For example, we want to see our network, write **Y** and then press **ENTER**

How to calculate generalize time and what it is?

- GT is used to determine the route choice by traveler. It is clear that a traveler chooses a route with the minimum GT.
- The value of time will be lower or value of length will be higher in term of the cities with the low personal income
- For example: A link with FFS 100 kph, length 8 km.

  What is the generalized time value with

  GT = 0.25*length + 0.75*time ?

- Answer :

  100 kph = 1.7 kpm

  0.25*8 + 0.75*(8/1.7) = 5.56

Calculating Shortest Route Tress

- Choose **CAR TIMES OD PAIRS** and press **ENTER**
- Three menus:

  [1].. Fast (Default)

  [2].. Fast Tress

  [3].. Slow Tress

- Each menu has a similar calculation method. Please try one by one by write **1** or **2** or **3** and then press **ENTER**

- Appear: **Access time FROM centroid to network + vice versa (default = 8 minutes)**

It means that the time needed from centroid zone to the network is 8 minutes

- Press **ENTER** if our access/egress time is 8 minutes
- For example: 4 minutes for access and egress time

  Write **4** and press **ENTER**

  If yes, press **ENTER**

- The program visualizes the principles of the shortest route calculation
- The fat point indicates from which node the route tree is calculated
- Press **F4** and then press **ENTER** to speed up

UNIMODE ORIGIN AND DESTINATION MATRIX

- Choose **DISTRIBUTION** and press **ENTER**
- Two choices

  [1].. Calculation (default)

  [2].. Input by User
- Write **1** and then press **ENTER**

- Four choices:

  [1].. Given Land use (default)

  [2].. Endogeneous land use

  [8].. Restart

  [9].. QUIT

- Write **1** (Choose **Given Land Use**) and press **ENTER**
- On screen the car network appears with speeds and road capacities
- If we want to change the scale factor, write and press **ENTER**
- For example: scale becomes 400, write **400** and press **ENTER**
- Press **ENTER** twice

- Appear: **Access time FROM centroid to network + vice versa (default = 8 minutes)**

  This value is similar to the previous input and its explanation

  Write the value and press **ENTER**

- On screen the value of origin and destination in each zone
- Please note:
  - 1 cars/adult
  - Working area = jobs = total employment
  - Residential area = working residences = working population
  - Only shows the higher one between generated trips and attracted trips
- If we want to change the scale factor, write and press **ENTER,** for example write **4** and press **ENTER**
- Press **ENTER** for 3 times

- Appear : **<Y> if you use trip ends by car ?**

  Write **Y,** if 1 car = 1 adult

  Write **N,** if 1 car ≠ 1 adult

  For example, write **N** and press **ENTER**
  - Appear : **1 cars/adult. New value for this period ?**
  - Write **1 (default),** if 1 car = 1 adult
  - If there are 2 adults inside a car, write **0.5** and so forth
  - For example, write **0.5** and press **ENTER**

- Appear : **Detterence Function**

  EXP [-0.4 * {LOG (1*Z + 1)}^{2}]

  Write **1** and press **ENTER**

  Detterence function is the probability of trips decrease if GT increase

- Appear : **All right (Y/N)**

  Write **Y,** if agree with our data

  Write **N,** if disagree

- There are several options:

  [1].. Work - home (default)

  [2].. All (workday)

  [3].. All (peak hour)

  [8].. Restart

  [9].. Quit

- For example, we consider merely on trips from work to home

- Write **1** and press **ENTER**

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- Appear **: Working Population = 100% adults**
  - Working population means number of adults who work within a study area.
  - Adult means number of adults who live within a study area
  - If there are 100 adults, but only 50 adults who work, working population = 50% of the adult
  - OVG = 35% is a standard ratio between working population and total adult population
  - In our calculation, we calculate the trips of adult, not trips of working population

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For example working population is 50 % of adult

- Write **50** and press **ENTER**
- It is clear that total adults = 2 x working population
- Since 1 car = 2 adults, therefore each adult conduct 0.5 trips
- If yes, press **ENTER**

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- Appear : **Peak Hour Factor**
  - Ratio between number of trip departing during the peak hour and during a workday
  - For example, there are 100 trips at peak hour and 1000 trips within a workday. Due to this, peak hour factor is 10%
  - For example, PHF is 0.6: Write **0.6** and press **ENTER**

- Appear : **All right (Y/N)**

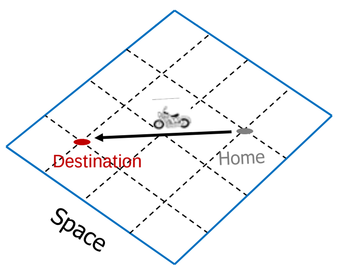
  Write **Y,** if agree with our data

  Write **N,** if disagree

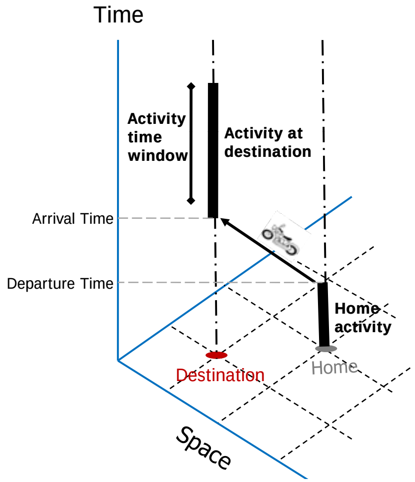
ASSIGNMENT

- **2D ASSIGNMENT**
- **3D ASSIGNMENT**

2D ASSIGNMENT



3D ASSIGNMENT



- Choose **2D ASSIGNMENT** and press **ENTER**

- Several Options:

  [1].. All or Nothing

  [2].. Equilibrium

  [3].. Stochastic

  [4].. [2] and [3]

  [8].. Restart

  [9].. Quit

- For example, choose All or Nothing Model: Write **1** and Press **ENTER**

- On Screen the Volume Capacity Ratio
- Write the Scale Factor if we want to change

  For example: Write **2000** and press **ENTER**
- To zoom, press **F4** and press **ENTER**

  Use the cursor keys to move the frame

  Use **<+>** or **<->** to enlarge or reduce the frame

  Press **ENTER** to execute the enlargement

- Other assignment: Equilibrium.

  Write **2** and press **ENTER**
- 2 Options:

  [1].. Users Optimum

  [2].. System Optimum
- For example, choose User Optimum. Write **1** and Press **ENTER**

- Appear : **Delay Function**
- As have been explained
  - Use A = 0,15, Write **0.15** and press **ENTER**
  - Use B = 4, Write **4** and press **ENTER**
- Program is working
- Equilibrium occurs if the **improvement factor** is equal to or close to **NOL.** Press **ENTER** several times until reached

- Improvement factor is the difference in the system time between two iteration respectively

$$IF = \left(\sum_a v_a \, . \, Z_a \right) - \left(\sum_a v_a^{\,i+1} \, . \, Z_a^{\,i+1} \right)$$

Saving the Data

- Saving our input data: Go to **USERFILE** and choose **SAVE**
- Saving our output data: Go to **SAVE/PRINT REPORT**
- Saving picture: Press **PRINTSCREEN** when our picture appears, and paste to Paint or MS.Word
- Exit from the TFTP program: Go to **FINISH**

Analyzing the Network Performance in Equilibrium Model

- Total length of all links in the network (km) = $\sum_a l_a$
- Mean link capacity (cars/hour) = $(\sum_a c_a \, . \, l_a) / \sum_a l_a$
- Traffic Density (% within a network)

  = $(\sum_a v_a \, . \, l_a) / (\sum_a c_a \, . \, l_a)$
- Total time in the unloaded network = $(\sum_a v_a \, . \, Z_{min\ a})$
- Total time in the loaded system = $(\sum_a v_a \, . \, Z_a)$

THANK YOU