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)

\[ R^2 = 0.736 \]
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)

TFTP 2D Assignment Methods:

- **All or Nothing Assignment**
  The implicit assumption is made that all drivers 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:

\[ v_a = \sum_i \sum_f \sum_r T_{ijr} \delta_{ijr} \]
Pseudo Stochastic Assignment or Logit Assignment

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

Equation:

\[
\Pr\{U_r < \min(U_r^*)\} = \frac{e^{-U_r}}{e^{-U_r} + \sum_r e^{-U_r^*}}
\]

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:

\[ Z_{qa} = Z_{\text{min} a} \left[ 1 + \alpha \left( \frac{V_a}{C_a} \right)^\beta \right] \]

- \( Z_{qa} \): time on the loaded link \( a \)
- \( Z_{\text{min} a} \): time on the unloaded link \( a \)
- \( V_a \): the link flow on link \( a \)
- \( C_a \): the link capacity of \( a \)
- \( \alpha \): parameter, usually 0.15
- \( \beta \): parameter, usually 4

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

\[ \text{Min } \nu_a = \left\{ \sum_a \left( Z_{\nu_a} \cdot t_{\nu_a} \right) \right\} \]

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.
STARTING THE PROGRAM

- Click **TFTP program**
- There are 2 options:
  - Press **F5** to Continue
  - Press **F10** for Program Information

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, let’s 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

<table>
<thead>
<tr>
<th># Node</th>
<th>X Axis</th>
<th>Y Axis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>8</td>
</tr>
</tbody>
</table>
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
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 Y if within Zone A, The value of generation is equal to attraction
Write N if otherwise

Write <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

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

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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
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
• **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**

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• 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

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**UNIMODE ORIGIN AND DESTINATION MATRIX**

• Choose **DISTRIBUTION** and press **ENTER**

• Two choices
  1. Given Land use (default)
  2. Endogeneous land use
  3. Restart
  4. QUIT

• Write 1 and then press **ENTER**
- 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
**Deterrence Function**

\[ \text{EXP} \left[-0.4 \times \left(\log (1+Z+1)\right)^2\right] \]

Write 1 and press **ENTER**

Deterrence function is the probability of trips decrease if GT increase.

**All right (Y/N)**

- Write **Y**, if agree with our data
- Write **N**, if disagree

**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.

For example working population is 50% of adults.

- 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**

**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**
**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.

Choose 2D ASSIGNMENT and press ENTER.

**Several Options:**
1. All or Nothing
2. Equilibrium
3. Stochastic
4. [2] and [3]
5. Restart
6. 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

\[
IF = \left( \sum a \cdot Z_a \right) - \left( \sum a \cdot Z_{a}^{i+1} \right)
\]
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) = \( \sum a \cdot l_a \)
- Mean link capacity (cars/hour) = \( \frac{\sum c_a \cdot l_a}{\sum l_a} \)
- Traffic Density (% within a network) = \( \frac{\sum v_a \cdot l_a}{\sum c_a \cdot l_a} \)
- Total time in the unloaded network = \( \sum v_a \cdot Z_{\text{min}} \cdot l_a \)
- Total time in the loaded system = \( \sum v_a \cdot Z_a \cdot l_a \)

THANK YOU