Fastest Route Problem Using Weighted Shortest Route Technique
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Abstract
The shortest path problem is a transport network usually concerns with determining the shortest distance between a source and a destination. The problem is normally faced by police department, fire department and hospital emergency services where immediate services are required from them in any given time of the day. The problem concerned involves multiple sources, forty arcs and twenty four destinations. The algorithm developed in this model uses SAS OR is deciding which route to be used at different time of the day. A real case study was done in the city of Kuala Lumpur, Malaysia to assist the fire department, police and hospital in deciding which route to follow at a given time of the day. A weighted shortest route problem was designed to ensure that the time required to reach the desired destination is the shortest time (and not necessarily the shortest route). Constraints like traffic intensity is included in the model. The shortest path method developed in this paper is an acyclic network.

Keywords: Procedure, shortest route, fastest route, acyclic network.

Introduction
The hospitals, police and fire departments often face with the problem of finding the fastest (not necessarily the shortest) route when responding to an emergency call. The problem becomes more complicated when their services are needed during peak hours. It becomes more critical when the place of interest is of distant and the decision to follow which route is vague.

The development of Fastest Route (FR) aims to assist the fire hospitals, police and fire departments in choosing which route to follow in any time of the day. The solution procedures for this problem is performed as follows:

Phase 1: Initial study on problems faced by hospitals, police and fire departments in dealing with emergency problems and their methods of getting to the scene. In this study, hospitals, police and fire departments were considered as sources since it is from these places that emergency services were needed. Difficulty arises in determining the number of destinations as every part of the city can be considered as destination (or sink). One of the approach is to group together various small precincts and regard them as one destination. The assumption here is that time travel within the small precinct is insignificant. This not only reduces the number of destinations but also the number of arcs.

Phase 2: Gathering information on traffic intensity during any time of the day. Traffic intensity varies given the time of a day. Traffic intensity varies given the time of a day. Traffic intensity varies given the time of a day. Traffic intensity varies given the time of a day. Traffic intensity varies given the time of a day. Traffic intensity varies given the time of a day.

Phase 3: Developing of Fastest Route model.

Scope
The scope of this project concerns with roads and highways in the city of Kuala Lumpur, Malaysia. The final output of this project will determine a unique fastest route from source to destination for the fire department, police and hospitals. Overall, there are about forty main routes or arcs, eighteen sources (2 hospitals, 8 police department and 8 fire departments) and twenty four known destinations (grouped together).

Model Development
Shortest technique uses the following formula:

\[ d(ij) = \min \{ d(ij) + d(i,j) \} \]

where

- \( d(ij) \) : shortest distance from nod i to nod j
- \( d(i,j) \) : distance from nod i to nod j
- \( d(i,j) = 0 \)

For the purpose of the project, the formula was modified by including a busy factor:

\[ d(ij) = \alpha \{ d(i-1) + d(i,j) \} \]

where

- \( \alpha \) : busy factor from nod i to nod j.

The value of \( \alpha \) is now in terms of time.

Based on the four categories of traffic intensity, the busy factor varies according to the date and time of the day. Traffic intensity also varies during holidays and weekends. Besides time and date factors, few roads/highway does exhibit suspicious findings even during peak hours. This, we presume is the result of the randomness of events under study.

<table>
<thead>
<tr>
<th>Time of the day</th>
<th>Traffic Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>22:00 - 6:00</td>
<td>Clear</td>
</tr>
<tr>
<td>6:31 - 7:00</td>
<td>Busy</td>
</tr>
<tr>
<td>7:01 - 9:30</td>
<td>Very Busy</td>
</tr>
<tr>
<td>9:31 - 12:45</td>
<td>Normal</td>
</tr>
<tr>
<td>12:46 - 14:30</td>
<td>Busy</td>
</tr>
<tr>
<td>14:31 - 19:30</td>
<td>Very Busy</td>
</tr>
<tr>
<td>19:31 - 20:30</td>
<td>Busy</td>
</tr>
<tr>
<td>20:01 - 21:39</td>
<td>Normal</td>
</tr>
</tbody>
</table>

Languages and Softwares
Pascal
Pascal were used to create the main menu. In the main menu, users are given five options namely:

1. Editing Network Information
2. Set FROM_NODE and TO_NODE
3. Do The Analysis
4. Display The Fastest Route
5. Print The Fastest Route

Option 1 is for editing network information. Upon entering this menu a second submenu will be displayed as shown below.

EDITING NETWORK INFORMATION MENU

1. - 1 Adding New Route
1. - 2 Deleting Route
1. - 3 OFF The Route
1. - 4 ON The Route
1. - 5 Editing Busy Factor

Option 1 - 1 allows user to add new route in the network. Option 1 - 2 allows user to delete any route from the network which cease to exist. Option 1 - 3 and 1 - 4 allows user to choose an existing road upon repair work in progress and open again after the repair work has been completed. Option 1 - 5 allows user to edit the busy factor should there occur any changes in traffic intensity given a particular time.

Option 2 from the main menu allows user to type in the desired source to the desired destination. Here the names of all towns are simplified to the first initial only. For example if user desire to start from highway named Kelana, typing the letter K would display the user all highways having first name starting from the letter K.

After setting the source and destination, user will have to choose option 3 from the main menu to perform the required analysis. Calculations for determining the fastest route in the acyclic network will be executed. Calculations are fulfilled by the SAS Network Procedure without any knowledge of the user.

Option 4 from the main menu will display the output of the calculations executed at main menu 3. Output from the SAS file will be exhibited on the screen. User can also print the final output when choosing option 5.

Batch commands were also created to interface between main menu, SAS procedures and Diabe.

Diabe
Data are kept in Diabe file. Here users can edit, browse, delete or add new data. The format of the data file exactly with the format of SAS file. Since Diabe runs on window, users will find that the menu is very user friendly.
SAS Programming

SAS Network is used to obtain the required output. Users do not have to get into SAS in the real network. By choosing menu number 4 in the main menu, actual calculations are done. The user does not need to know the SAS procedure. Shown below are parts of the SAS programs and procedure.

<table>
<thead>
<tr>
<th>SAS Programming</th>
<th>PROC NETFLOW;</th>
</tr>
</thead>
<tbody>
<tr>
<td>USER statement</td>
<td>proc netflow;</td>
</tr>
<tr>
<td>input flonets $</td>
<td>proc netflow;</td>
</tr>
<tr>
<td>s 15. mod $</td>
<td>proc netflow;</td>
</tr>
<tr>
<td>s 515 roads $</td>
<td>proc netflow;</td>
</tr>
<tr>
<td>dist o,s PATH</td>
<td>proc netflow;</td>
</tr>
<tr>
<td>cards</td>
<td>proc netflow;</td>
</tr>
</tbody>
</table>

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JINJANG TUN ISMAIL IPOH 3.3 23
TUN ISMAIL IPOH 3.2 15
BKT TUNKU IPOH 4.9 19
BKT TUNKU TUN ISMAIL 4.6 12
PARK TANJUNG DUTA 6.0 22
PARK TANJUNG BRICKFIELD 11.7 12
PARK TANJUNG DAMANSARA 11.8 15
BANGSAR PARK TANJUNG 7.2 12
PARK TANJUNG H UNIVERSITI 11.8 7
BKT TUNKU IPOH 4.2 7
BKT TUNKU TUN ISMAIL 10.4 19
S1 JINJANG KUCING 13.9 11
S1 KUCING S1 3.9 10
S2 KUCING S2 8.3 13
S5 DUTA S5 2.9 19
S5 DUTA S5 17.1 10
DAMANSARA BANGSAR TRAVEL 10.9 15
BANGSAR PARK TANJUNG 7.2 12
PARK TANJUNG H UNIVERSITI 11.8 7
BKT TUNKU IPOH 4.2 7
BKT TUNKU TUN ISMAIL 10.4 19
S1 JINJANG KUCING 13.9 11
S1 KUCING S1 3.9 10
S2 KUCING S2 8.3 13
S5 DUTA S5 2.9 19
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S1 JINJANG KUCING 13.9 11
S1 KUCING S1 3.9 10
S2 KUCING S2 8.3 13
S5 DUTA S5 2.9 19
S5 DUTA S5 17.1 10
BANGSAR PARK TANJUNG 7.2 12
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It is the desire of emergency services to get to the particular scene in less than 10 minutes. But traffic intensity which is unpredictable at any time of the day has caused unnecessary delays. With the development of this fastest route model, our hope is that emergency services would improve in due course. The model developed has been proven feasible and practical.

References
SAS/OR Manual, 1988, SAS Institute, N. Cary, USA.