

Evolving Dynamic Traffic Assignments

Andres Arribas

Thesis submitted to

obtain the degree of Master

in Artificial Intelligence

**Promoter:**

Prof. Dr. Tom Holvoet.

**Advisors:**

Rutger. Claes

Rinde. Van Lon

**Academic Year 2012 - 2013**

© Copyright by K.U.Leuven

Zonder voorafgaande schriftelijke toestemming van zowel de promoter(en) als de auteur(s) is overnemen, kopiëren, gebruiken of realiseren van deze uitgave of gedeelten ervan verboden. Voor aanvragen tot of informatie i.v.m. het overnemen en/of gebruik en/of realisatie van gedeelten uit deze publicatie, wend u tot de K.U.Leuven, Faculteit Ingenieurswetenschappen - Kasteelpark Arenberg 1, B-3001 Heverlee (België). Telefoon +32-16-32 13 50 & Fax. +32-16-32 19 88.

Voorafgaande schriftelijke toestemming van de promoter(en) is eveneens vereist voor het aanwenden van de in dit afstudeerwerk beschreven (originele) methoden, producten, schakelingen en programma’s voor industrieel of commercieel nut en voor de inzending van deze publicatie ter deelname aan wetenschappelijke prijzen of wedstrijden.

© Copyright by K.U.Leuven

Without written permission of the supervisor(s) and the authors it is forbidden to reproduce or adapt in any form or by any means any part of this publication. Requests for obtaining the right to reproduce or utilize parts of this publication should be addressed to K.U.Leuven, Faculty of Engineering - Kasteelpark Arenberg 1, B-3001 Heverlee (Belgium). Telephone +32-16-32 13 50 & Fax. +32-16-32 19 88.

A written permission of the supervisor(s) is also required to use the methods, products, schematics and programs described in this work for industrial or commercial use, and for submitting this publication in scientific contests.

Foreword

May this thesis be the high note with which this challenging but rewarding year at KU Leuven comes to a close.

I would like to express my thanks to my daily advisors Rutger Claes and Rinde van Lon, for their support and clarity of ideas. My appreciation too, to Willem Himpe who was generous with his time and explained to me the most important traffic concepts and the details of the original simulator.

Finally, I would like to dedicate this work to my family in Spain, always supportive despite the distance and to Judith, my team mate, my partner in crime, the only one with whom I want to ride the sweet risks of life.

Andres Arribas

Table of Contents (to update: right-click in list 🡪 ‘update field’)

[Foreword iii](#_Toc255384168)

[Table of Contents (to update: right-click in list 🡪 ‘update field’) iv](#_Toc255384169)

[Abstract **Error! Bookmark not defined.**](#_Toc255384170)

[Abstract iv](#_Toc255384171)

[List of figures and tables iv](#_Toc255384172)

[List of figures (to update: right-click in list 🡪 ‘update field’) iv](#_Toc255384173)

[List of tables iv](#_Toc255384174)

[List of abbreviations and symbols iv](#_Toc255384175)

[Chapter 1: Introduction 4](#_Toc255384176)

[Chapter 2: The first [full] chapter 4](#_Toc255384177)

[2.1 First subject in this chapter 4](#_Toc255384178)

[2.1.1 An item 4](#_Toc255384179)

[2.2 Second subject in this chapter 4](#_Toc255384180)

[2.2.1 An item 4](#_Toc255384181)

[2.3 Conclusion of this chapter 4](#_Toc255384182)

[Chapter 3: A new chapter 4](#_Toc255384183)

[3.1 First subject in this chapter 4](#_Toc255384184)

[3.1.1 An item 4](#_Toc255384185)

[3.2 Second subject in this chapter 4](#_Toc255384186)

[3.3 Conclusion of this chapter 4](#_Toc255384187)

[Chapter 4: The final chapter 4](#_Toc255384188)

[4.1 First subject in this chapter 4](#_Toc255384189)

[4.1.1 An item 4](#_Toc255384190)

[4.2 Second subject in this chapter 4](#_Toc255384191)

[4.3 Conclusion of this chapter 4](#_Toc255384192)

[Chapter 5: Conclusion 4](#_Toc255384193)

[Appendices 4](#_Toc255384194)

[Appendix A: The first appendix 4](#_Toc255384195)

[Appendix B: The final appendix 4](#_Toc255384196)

[Bibliography 4](#_Toc255384197)

[Master’s Thesis file 4](#_Toc255384198)

Abstract

Maximum 1 page

List of figures and tables

List of figures (to update: right-click in list 🡪 ‘update field’)

Figure 2 castle 4

Figure 4 airplane 4

Figure 6 www etc 4

List of tables

Table 2 This is the first table containing data **Error! Bookmark not defined.**

Table 4 A second table **Error! Bookmark not defined.**

List of abbreviations and symbols

π the number pi

∞ infinity …

Chapter 1: Introduction

This chapter gives an introduction to the work. The objective is stated and an explanation is given of how it is to be achieved (better known as the theme). If you are not sure what a master’s thesis is, you can always look it up on Wikipedia[2].

Example of an embedded image:

(once inserted 🡪 right-click ‘insert caption’: choose between figure or table 🡪 ‘Automatically update list of figures and tables on page viii: right-click: update field)



Figure 1 castle

Chapter 2: Traffic Theory

In this chapter basics of traffic theory are explained. The objective is to serve as an introduction to the most important concepts directly used in this thesis. Out of scope remains to give an exhaustive, or even elaborate, picture of the field.

2.1 Traffic Systems Modelling

Transportation systems can be studied from a variety of angles e.g. economic, social, purely mathematical, etc., and at different scales e.g. regional, local or state wise.

In this thesis we are only concerned with a simplified view of what a transportation system is: we will focus on simulating simple small traffic networks and measuring their efficiency in terms of performance (e.g. travel times) given predefined fictional travel demands.

In order to simulate a traffic system, the first step is to model it.

A traffic model is a mathematical representation of the physical and organisational elements comprising a traffic network, as well as the travel demand and the emerging interactions.

Even the simplest traffic models have to take into consideration the inherent complexity of transportation systems, which arises from the multiplicity of non-linear interactions and feedback cycles.

In order to do so, a traffic model is most commonly defined by means of a combination of a traffic flow theory and a network flow theory. The former is used to analyse and simulate the performances of the main supply elements, the latter to represent the topological and functional structure of a system.

The traffic flow theory used in this work is a very specific one that requires careful consideration. We will dedicate an in depth analysis to it. But first, let us briefly summarize the fundamentals of network flow theory, which once presented will be left untouched.

2.2 Network Flow Theory[[1]](#footnote-1)

In this section we look at the foundations of congested network models.

2.2.1 Network Structure

A network structure is represented by a directed graph. A directed graph consists of a set of nodes, N, and a set of connections between pairs of nodes, L, called links, such that L SYMBOL NxN. In a directed graph links are oriented.

A link does not necessarily correspond to a construction in the physical world. Links rather represent phases and/or activities of possible trips between different traffic zones. The core idea behind a link is that its physical and functional characteristics can be assumed to be homogeneous for the whole link. In this sense, links can be seen as the partition of trips into segments, each of which has certain characteristics.

Nodes correspond to significant events delimiting trip phases. A node can represent the same event occurring at different time instants (between two trip phases). For example, the different entry or exit times in a road segment.

A trip is a sequence of several phases/links called a path. A path is defined from an initial node, the origin, to a final node, the destination. Each path is unambiguously associated with one, and only one O-D pair, whereas several paths can connect the same O-D pair.

[ref and pic p 47]

2.2.1 Flows

An instantaneous link flow is the instantaneous number of units using a link (i.e. units in that phase of the trip at that time instant).

PB with the previous and time [AAN]

[REV POSSIBLE FORMULAS]

Typically, when computing the link flow, the difference between types of units has to be taken into account, however, in this work, we consider all units to be of the same homogenous type.

A path flow is obtained as the sum of the link flows for all links in the path, considering in the flow calculations only those units matching the origin and destination of the path.

2.2.1 Performance Variables and Transportation Costs

Some variables perceived by the users can be associated to individual trip phases. Examples of such variables are travel times, monetary cost, and discomfort. These variables are referred as level-of-service or performance attributes. In general, performance variables correspond to disutilities or costs for the users.

Given our limited scope and simplified approach we focus on travel times as the only performance variable. Accordingly, from now onwards, “travel time”, “cost” and “performance variable/indicator” may be used indistinctly.

The Eiffel Tower has three floors:

the first;

the second;

the third.

But do this:

The Eiffel Tower has three floors: the first, the second and the third.

2.2.1 Flows

blabla

2.2.1 Performance Variables

2.3 Conclusion of this chapter

If you have reached important findings or conclusions in this chapter, it is only logical that you should end the chapter by summarising them. This is not necessary for chapters such as the introduction or list of the cited literature.

|  |  |  |
| --- | --- | --- |
|  | 1 | 2 |
| A | A1 | A2 |
| B | B1 | B2 |
| C | C1 | C2 |

Table 1 This is the first table containing data

Text

|  |  |  |
| --- | --- | --- |
|  | 1 | 2 |
| 1 | 11 | 12 |

Table 2 A second table

Chapter 3: A new chapter

A chapter contains a cohesive[[2]](#footnote-2) whole that stands, more or less, on its own. It is therefore only logical that it should start with an introduction, i.e. that part of the text which you are now reading.

3.1 First subject in this chapter

Information introducing the subject.

3.1.1 An item

Text is never presented on its own. This means that references are bound to be needed. Reference can be made to online documents[2] or books[3].

3.2 Second subject in this chapter

A chapter will contain several subjects. Let us assume that this one is the last.

3.3 Conclusion of this chapter

If you have reached important findings or conclusions in this chapter, it is only logical that you should end the chapter by summarising them. This is not necessary for chapters such as the introduction or list of the cited literature.



Figure 2 Airplane

Chapter 4: The final chapter

A chapter contains a cohesive whole of information that stands, more or less, on its own. It is therefore only logical that it should start with an introduction, i.e. that part of the text which you are now reading.

4.1 First subject in this chapter

Information introducing the subject.

4.1.1 An item

The accompanying text. Remember to keep paragraphs long enough, but make sure the sentences are not too long.

A paragraph contains a train of thought and so will always contain a couple of sentences. Do not write a paragraph which consists of only one line.



Figure 3 www etc

4.2 Second subject in this chapter

A chapter will contain several subjects. Let us assume that this one is the last.

4.3 Conclusion of this chapter

If you have reached important findings or conclusions in this chapter, it is only logical that you should end the chapter by summarising them. This is not necessary for chapters such as the introduction or list of the cited literature.

Chapter 5: Conclusion

The master’s thesis is brought to a close with a chapter summarising all the conclusions once again. This is also the place to include suggestions on further use of the results, in both industrial applications and further research.

Appendices

Appendix A: The first appendix

The appendices contain information that is likely to be useful to the reader, but not essential to a sound understanding of the argument in the normal body of text. Examples include source files, configuration information, lengthy mathematical deductions, etc.

Needless to say, an appendix may be further divided into sections, or contain figures and references[1].

Appendix B: The final appendix

The appendices contain information that is likely to be useful to the reader, but not essential to a sound understanding of the argument in the normal body of text. Examples include source files, configuration information, lengthy mathematical deductions, etc.

Bibliography

[1] D. Adams, The Hitchhiker’s Guide to the Galaxy. Del Rey (reprint), 1995, no.

ISBN-13: 978-0345391803.

[2] Scriptie. Last reviewed: 31 March 2008. [Online].

Available at: <http://nl.wikipedia.org/wiki/Masterproef>

[3] T. Pratchett and N. Gaiman, Good Omens: The Nice and Accurate Prophecies of Agnes Nutter, Witch. HarperTorch (reprint), 2006, no. ISBN-13: 978-0060853983.

K.U.Leuven Faculty of Engineering 20xx-20xx

Master’s Thesis file

Students: First name Surname

Title: Title of master’s thesis

English title: English translation of the title

UDC:

Content in brief: (maximum 500 words)

(Title of the article: Title of the article)

(English translation: English translation of the title)

Thesis submitted to obtain the degree of Master in Engineering: ….....................................

Supervisor(s):

Assessors:

Mentor(s):

1. This section is essentially based on reformulatedof excerpts from Cascetta’s, section 2.3. [↑](#footnote-ref-1)
2. Insert footnote via References 🡪 insert footnote [↑](#footnote-ref-2)