

Transportation Planning

Applied Optimization

Volume 64

Series Editors:

Panos M. Pardalos
University of Florida, U.S.A.

Donald Hearn
University of Florida, U.S.A.

The titles published in this series are listed at the end of this volume.

Transportation Planning

State of the Art

Edited by

Michael Patriksson

*Department of Mathematics,
Chalmers University of Technology, Gothenburg, Sweden*

and

Martine Labbé

*ISRO and SMG,
Université de Bruxelles, CP 210-01,
Bruxelles, Belgium*

KLUWER ACADEMIC PUBLISHERS

NEW YORK, BOSTON, DORDRECHT, LONDON, MOSCOW

eBook ISBN: 0-306-48220-7
Print ISBN: 1-4020-0546-6

©2004 Kluwer Academic Publishers
New York, Boston, Dordrecht, London, Moscow

Print ©2002 Kluwer Academic Publishers
Dordrecht

All rights reserved

No part of this eBook may be reproduced or transmitted in any form or by any means, electronic, mechanical, recording, or otherwise, without written consent from the Publisher

Created in the United States of America

Visit Kluwer Online at: <http://kluweronline.com>
and Kluwer's eBookstore at: <http://ebooks.kluweronline.com>

Contents

Preface	ix
1	
Origin-Based Network Assignment	1
<i>Hillel Bar-Gera, David Boyce</i>	
1.1 Introduction	1
1.2 Problem statement	2
1.3 Review of solution methods for TAP	4
1.4 An origin-based method for TAP	6
1.5 Experimental results	7
1.6 Discussion	13
1.7 Conclusions	14
2	
On Traffic Equilibrium Models with a Nonlinear Time/Money Relation	19
<i>Torbjörn Larsson, Per Olov Lindberg, Michael Patriksson, Clas Rydergren</i>	
2.1 Introduction	20
2.2 The time-based traffic equilibrium problem	21
2.3 Solution approaches	23
2.4 A route generation algorithm	26
2.5 Numerical tests	27
3	
Stochastic Network Equilibrium Under Stochastic Demand	33
<i>David Watling</i>	
3.1 Introduction	33
3.2 Notation	35
3.3 Critique of SUE in the context of day-to-day variability	37
3.4 Equilibrium conditions: fixed demand	40
3.5 Equilibrium conditions: stochastic demand	44
3.6 Solution algorithm	45
3.7 Numerical tests	46
3.8 Conclusion	49
4	
Stochastic Assignment with Gammit Path Choice Models	53
<i>Giulio Erberto Cantarella, Mario Giuseppe Binetti</i>	
4.1 Introduction	53
4.2 Review of stochastic assignment	55

4.3	Probabilistic path choice models	59
4.4	Numerical examples	63
4.5	Conclusions	66
5		
	Estimation of Travel Time Reliability	69
	<i>Chris Cassir, Michael G.H. Bell</i>	
5.1	Introduction	69
5.2	Logit SUE model	72
5.3	Logit SUE sensitivity analysis	72
5.4	Approximation of travel times variances	77
5.5	Example	77
5.6	Conclusion	83
6		
	A Joint Model of Mode/Parking Choice with Elastic Parking Demand	85
	<i>Pierluigi Coppola</i>	
6.1	Background and objectives	85
6.2	The parking choice sub-model	88
6.3	The mode choice sub-model	95
6.4	Simulation of realistic parking policies	97
7		
	A New General Equilibrium Model	105
	<i>Yanling Xiang, Michael J. Smith, Miles Logie</i>	
7.1	Introduction	106
7.2	DREAM—The general equilibrium model	108
7.3	An outline of the DREAM model	109
7.4	Features of the general equilibrium model	113
7.5	Test Results	116
8		
	Macroscopic Flow Models	119
	<i>J.P. Lebacque, M.M. Khoshyaran</i>	
8.1	Introduction	119
8.2	The basic model LWR model for a link	120
8.3	Partial flow models for links	122
8.4	Intersection modeling	126
8.5	Intersection models as solutions of optimization problems	133
8.6	An experimental validation	136
8.7	Conclusion	137
9		
	AIMSUN 2 Simulation of a Congested Auckland Freeway	141
	<i>John T Hughes</i>	
9.1	Introduction and objectives	141
9.2	Simulation model	142
9.3	AIMSUN 2 simulation process	144
9.4	Study area and scope	144
9.5	Model development	146
9.6	Geometric information	146
9.7	Traffic flow information	147

9.8	Trip matrices	147
9.9	Driver and vehicle information	147
9.10	Maximum vehicle acceleration	149
9.11	Motorway model	151
9.12	Model outputs	153
9.13	Lane utilisation	153
9.14	Motorway speeds	154
9.15	Greenlane Northbound on-ramp	155
9.16	Calibration parameters	156
9.17	Run times	159
9.18	Conclusion	159
9.19	Postscript	160
10		
	Fuzzy Traffic Signal Control	163
	<i>Jarkko P. Nittymäki</i>	
10.1	Introduction	163
10.2	Fuzzy traffic signal control	163
10.3	Fuzzification interface	166
10.4	Defuzzification of outputs	170
10.5	Conclusions	174
11		
	An Urban Bus Network Design Procedure	177
	<i>S. Carrese, S. Gori</i>	
11.1	Introduction	177
11.2	The main transit network (MTN)	178
11.3	The main transit lines (MTL)	181
11.4	Feeder lines	185
11.5	Model application and results	186
11.6	Conclusions	193
12		
	The Cone Projection Method	197
	<i>Michael J. Smith, A. Battye, A. Clune, Y. Xiang</i>	
12.1	Introduction	198
12.2	Achieving the complementarity formulation	198
12.3	A cone field method of calculating equilibria	203
12.4	The cone projection method	205
12.5	A simple method	207
12.6	Conclusion	209
13		
	A Park & Ride Integrated System	213
	<i>Chafik Allal, Benoit Colson, Bernard Fortz</i>	
13.1	Introduction	214
13.2	A Park & Ride Integrated system	215
13.3	Routing model	217
13.4	Travel time prediction	221
13.5	Computational results	225
13.6	Conclusion	227

Longitudinal Analysis of Car Ownership in Different Countries	229
<i>Akli Berri</i>	
14.1 Introduction	229
14.2 An age-cohort-period model	230
14.3 A multinational comparison	233
14.4 A comparative analysis for homogeneous zones	239
14.5 Long term forecasting using the demographic approach	241
14.6 Summary and conclusions	242
Index	247

Preface

This book collects selected presentations of the 6th Meeting of the EURO Working Group on Transportation, which took place at the Department of Mathematics at Chalmers University of Technology, Göteborg (or, Gothenburg), Sweden, September 9–11, 1998. [The EURO Working Group on Transportation was founded at the end of the 7th EURO Summer Institute on Urban Traffic Management, which took place in Cetraro, Italy, June 21–July, 1991. There were around 30 founding members of the Working Group, a number which now has grown to around 150. Meetings since then include Paris (1993), Barcelona (1994), and Newcastle (1996).] About 100 participants were present, enjoying healthy rain and a memorable conference dinner in the Feskekôrka.

The total number of presentations at the conference was about 60, coming from quite diverse areas within the field of operations research in transportation, and covering all modes of transport:

- Deterministic traffic equilibrium models (6 papers)
- Stochastic traffic equilibrium models (5 papers)
- Combined traffic models (3 papers)
- Dynamic traffic models (7 papers)
- Simulation models (4 papers)
- Origin–destination matrix estimation (2 papers)
- Urban public transport models (8 papers)
- Aircraft scheduling (1 paper)
- Ship routing (2 papers)
- Railway planning and scheduling (6 papers)
- Vehicle routing (3 papers)
- Traffic management (3 papers)
- Signal control models (3 papers)
- Transportation systems analysis (5 papers)

Among these papers, 14 were eventually selected to be included in this volume. A further selection of papers from the Meeting are being edited for a special issue of *Transportation Research, B*, devoted to public transport problems.

The 14 papers are described shortly as follows. *Chapter 1*, written by Bar-Gera and Boyce, describes a very promising approach to the traffic assignment problem which is founded on a fundamental property of user equilibrium flows, that for each origin the flows describe an acyclic subnetwork. *Chapter 2*, written by Larsson et al., illustrates that when combining time delays and money outlays into a generalized cost, user equilibrium flows resulting from the conversion $\text{time} \rightarrow \text{money}$ will be different from the result of using the conversion $\text{money} \rightarrow \text{time}$. A convex programming formulation is presented for the latter case, together with an algorithm for its solution. *Chapter 3*, written by Watling, proposes a variation of the stochastic user equilibrium (SUE) model to represent day-to-day stochastic variations in travel demands, and shows that the effect of such variations is a relatively stable mean link flow, but an increased link flow and total travel cost variance. *Chapter 4*, written by Cantarella and Binetti, analyzes the additive Gammit SUE model which is based on a Gamma distribution of route cost perception. This model satisfies stipulated conditions on probabilistic route-choice models, and is shown to yield results close to probit-based SUE models. *Chapter 5*, written by Cassir and Bell, presents a methodology for evaluating the reliability of transportation networks, which could be used to support the design of networks that are robust to everyday disturbances. In the case of the logit SUE route-choice model, reliability measures related to travel times are shown to be available efficiently, and are illustrated by means of numerical examples. *Chapter 6*, written by Coppola, notes that in previous models of parking management policies, parking search time is a neglected attribute which in reality should be a function of parking demand. A joint, nested logit model of mode and parking choice is then developed, and evaluated with data taken from an EC project. *Chapter 7*, written by Xiang et al., describes a general multi-modal traffic equilibrium model which embraces the classical four-step procedure into one combined model, including controls and stochastic travel costs. The main motivation for developing such a comprehensive model is to support the assessment of demand management strategies. *Chapter 8*, written by Lebacque and Khoshyaran, adapts the continuous Lighthill-Whitham-Richards model to dynamic traffic assignment. Included in the adaptation are specifications of partial and inhomogenous flows on links as well as several alternatives for intersection modeling. *Chapter 9*, written by Hughes, describes the application of the AIMSUN2 microscopic traffic simulation package to a section of a congested urban freeway in Auckland, New Zealand. Preliminary results show a good reproduction of speed and flow relationships, but less so for transient effects. *Chapter 10*, written by

Niittymäki, develops a fuzzy traffic signal control model for a signal control scenario with several conflicting optimization criteria. Several approaches to the fuzzification and defuzzification phases of fuzzy traffic signal control are discussed. *Chapter 11*, written by Carrese and Gori, describes a coordinated process for the design of a bus transit network, including both lines and frequencies. Heuristic methods construct the final plan through the sequential identification of a skeleton network, the main transit lines, and feeder lines. The model is applied to the Rome transit network system. *Chapter 12*, written by Smith et al., describes a descent algorithm for bilevel optimization in multi-modal equilibrium transportation models for the optimization of traffic control parameters. Convergence towards equilibrium points is ensured, and an intuitive motivation for the convergence of the control parameters towards points satisfying necessary optimality conditions are provided. *Chapter 13*, written by Allal et al., describes a demand-responsive park & ride transport system. Its real-time aspects are analyzed, and simulations results are reported. *Chapter 14*, written by Berri, analyzes household car ownership in seven countries, characterized by different economic and cultural contexts, by means of demographic modeling. Differences in long term forecasting results between countries and zones are explained by two main factors: the history of car ownership development and population density.

The Swedish Communications Research Board (KFB) supported the conference financially, as did Chalmers, for which we are grateful. We would like to thank the participants of the Meeting for making it enjoyable, and the referees for their duly work.

MICHAEL PATRIKSSON, GÖTEBORG, DECEMBER 2000