Comparing performance and quality of traffic assignment techniques for microscopic road traffic simulations (1/2)

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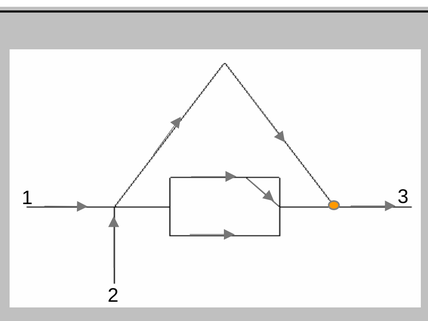
Summary

Focusing on the tradeoff between accuracy of the assignment and computation time this paper proposes different traffic assignment methods targeting at microscopic traffic simulation. The results indicate that the saving on computation time is significant with use of macroscopic assignments. However, the deficiency of neglecting turning behaviors in macroscopic assignments results in worse assignment results. Moreover, the used computation time of some microscopic methods (e.g. the one-shot method) is competitive with that of the macroscopic assignments. While the exact parameterization as well as the sensitivity of the methods to the size of the scenarios still need further investigation, it seems favorable to employ microscopic assignment techniques or hybrid methods for producing a good traffic assignment for a microscopic simulation.

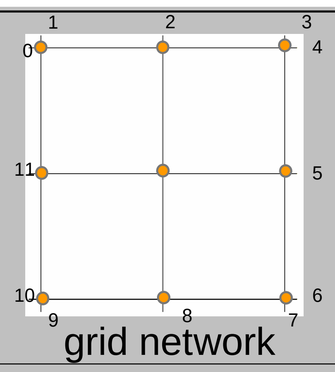
Compared Algorithms

Type	Algorithm (route choice probability)	
microscopic	DUA-Gawron : $p'_d(r) = \frac{p_d(r)(p_d(r)+p_d(s))\exp(\frac{\alpha\delta_{rs}}{1-\delta_{rs}^2})}{p_d(r)\exp(\frac{\alpha\delta_{rs}}{1-\delta_{rs}^2})+p_d(s)}$; $p'_d(s) = p_d(r)+p_d(s)-p'_d(r)$	
	simple Dijkstra	
	one-shot routing	• simple
		• rerouting $w(t,e)=\begin{cases} l(e)/v_{\max}(e) & t=0 \\ w(t-1,e)*r + l(e)/v_{curr}(t,e)*(1-r) & otherwise \end{cases}$
macroscopic	incremental assignment	
	SUE	• c-logit model $p(k)=\frac{\exp[\theta\cdot(C_k-CF_k)]}{\sum_{h\in R_{ij}}\exp[\theta\cdot(C_h-CF_h)]}$, $CF_k=\beta_0\ln\sum_{h\in R_{ij}}\left[\frac{L_{hk}}{L_h^{0.5}\cdot L_k^{0.5}}\right]^{\gamma}$
		• modified Lohse-logit model $p(k)=\frac{\exp[-(\beta\cdot X_k)^2]}{\sum_{h\in R_{ij}}\exp[-(\beta\cdot X_h)^2]}$, $X_k=\frac{C_k}{C_{\min,ij}}-1$

Test Networks

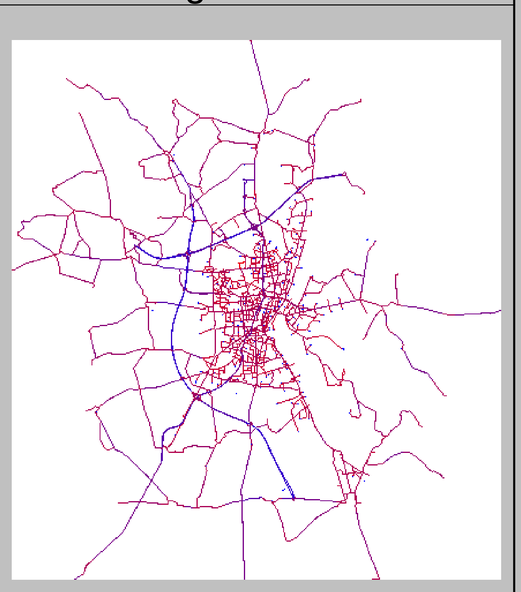


one-way network



grid network

Source: http://maps.google.de

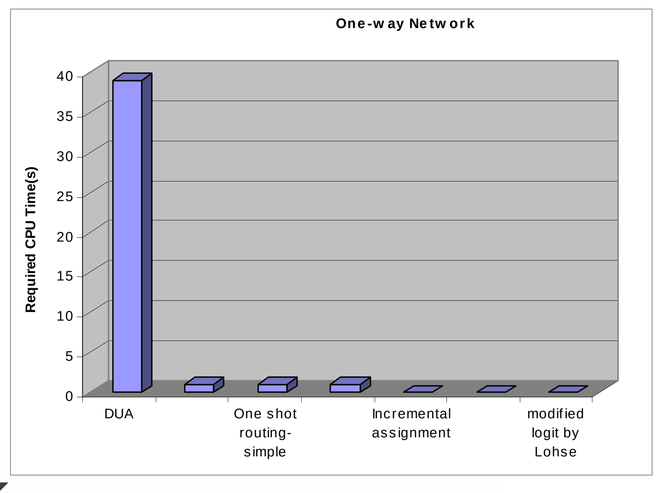


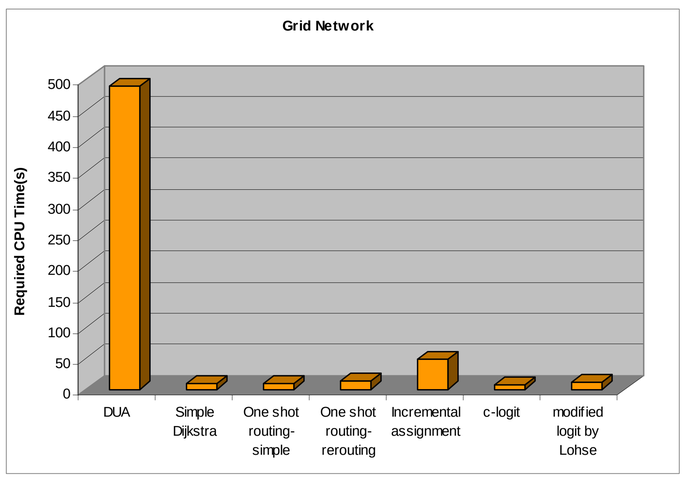
Magdeburg network

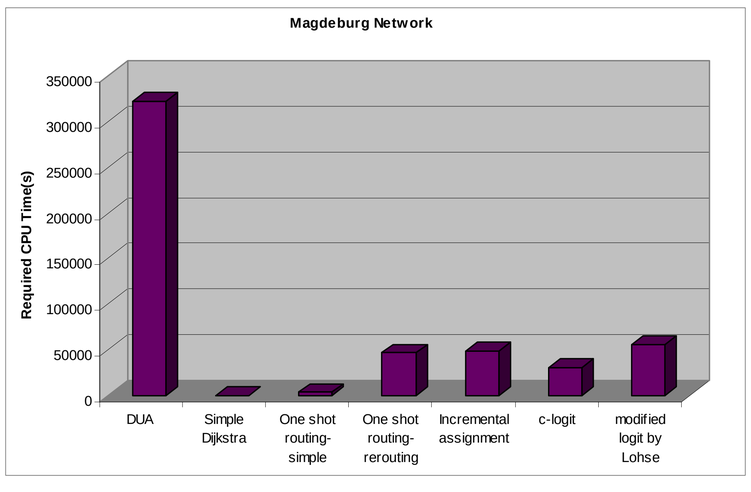
Analysis results

Required CPU time

- The saving on computation time is significant with use of macroscopic assignments. The DUA is the slowest method while one shot routing is quite comparable to the macroscopic techniques.







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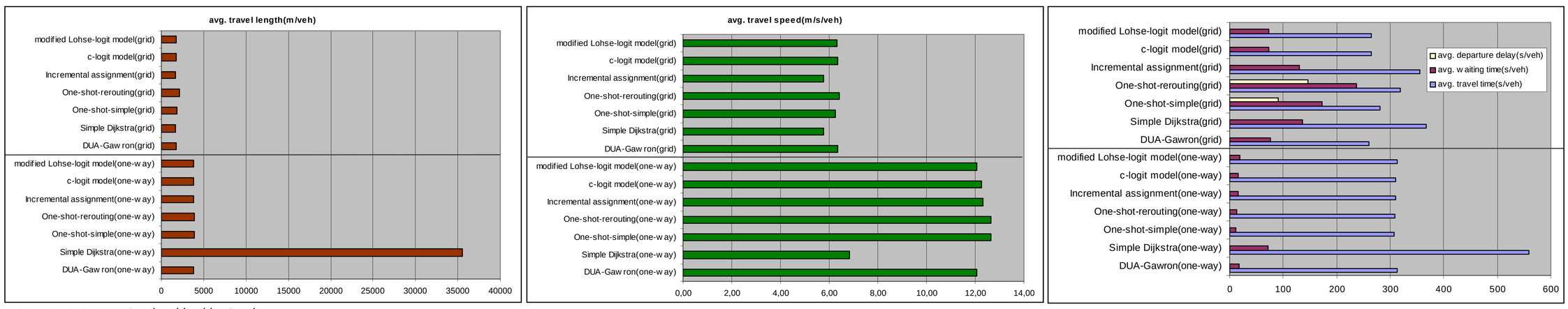
Analysis results

Network-wide performance

- In the one-way network, the performance measures based on either microscopic or macroscopic assignments are similar, expect the simple Dijkstra. The performance measures of the incremental assignment and the c-logit model are slightly better than the modified Lohse-logit model.
- In the grid network, the macroscopic SUE models deliver quite similar results when comparing to the microscopic DUA-Gawron model with the performance of the latter being slightly better. Vehicles based on the both one-shot routing methods have large departure delay, 90 and 146 seconds respectively. Such high departure delay results in fewer vehicles in the network during the simulation and some better performance measures. However, these performance measures are not representative in this situation.



one-way: one-way network; grid: grid network

- In the Magdeburg network, overflow situation had appeared when executing the macroscopic assignment models. It is mainly since the improper signal timing plans and the effect of turning behaviors were not considered. Lots of vehicles were thus not able to be released into the network during the simulation period. The DUA-Gawron and one-shot methods did not have the above-mentioned problem, since they tried to find the optimal solution, which probably does not correspond to the respective traffic situation in the reality.

Significance test

- The Kruskal-Wallis test is used for testing equality of the parameter sets. The results show that almost all tests are evaluated as statistically significant with 95% confidence interval, except the two SUE models in the grid network. It seems that, to a certain degree, these two models can be substitutable for each other.

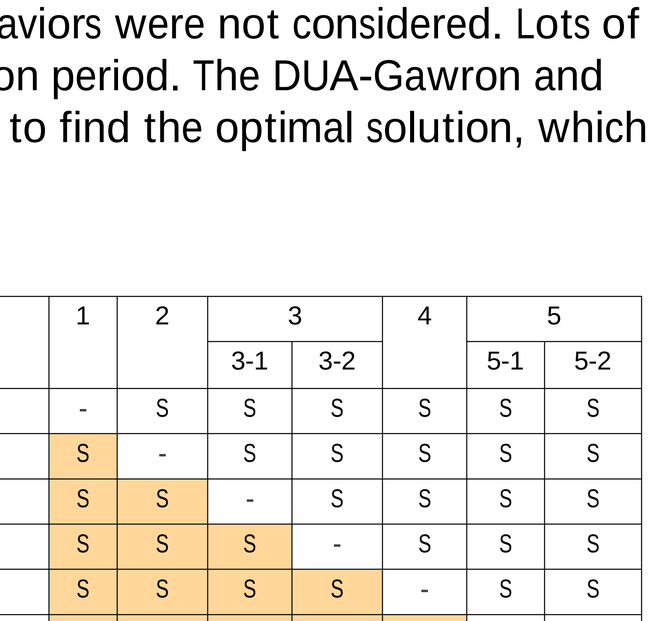
Assignment		1	2	3		4	5	
				3-1	3-2		5-1	5-2
1. DUA-Gawron*		-	S	S	S	S	S	S
2. Simple Dijkstra		S	-	S	S	S	S	S
3. One shot routing**	3-1 simple	S	S	-	S	S	S	S
	3-2 rerouting	S	S	S	-	S	S	S
4. Incremental assignment***		S	S	S	S	-	S	S
5. SUE	5-1 c-logit model	S	S	S	S	S	-	NS
	5-2 modified Lohse-logit model	NS	S	S	S	S	S	-

*: the number of iterations is 50; **: the period of the rerouting is 15 sec; ***: the number of iterations is 20; S: significant NS: not significant;
The test results of the one-way network and the grid network are indicated in the yellow area and the area without color respectively

Route set similarity

- Quite high similarity of route sets appeared due to the limited number of available routes in small networks, except with simple Dijkstra.
- Very high similarity between the two SUE models, makes it almost impossible to distinguish these two results.

Note:
1. Red dot: similarity index based on the maximum matching method;
2. Blue dot: similarity percent based on the 100% identical routes;
3. The greater the circle, the higher the similarity of the analyzed route sets.
4. Results of the one-way network and the grid network are indicated in the blue area and the area without color respectively



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