Deriving on-trip route choices of truck drivers by utilizing Bluetooth data, loop-detector data and variable message sign data

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Outline

Motivation

- On important truck-dominated motorways, a large share of traffic consists of trucks.
- Truck driver's routing decisions are different from passenger cars because of different constraints from the logistics system.
- Route choice of truck drivers is of interest to both transport planners and traffic management authorities.

[1] S. Hess, M. Quddus, N. Rieser-Schüssler, and A. Daly (2015). "Developing advanced route choice models for heavy goods vehicles using GPS data". In: *Transportation Research Part E: Logistics and Transportation Review* 77, pp. 29–44

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- Truck driver's routing decisions are different from passenger cars because of different constraints from the logistics system.
- Route choice of truck drivers is of interest to both transport planners and traffic management authorities.
- A major problem for route choice modeling has always been the need to capture appropriate data[1]. The strengths and weaknesses of both stated preference (SP) and revealed preference (RP) methods are widely known.
- We enrich an RP dataset with contextual information by utilizing multiple data sources to overcome the limitations of previous RP/SP studies.

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Objectives

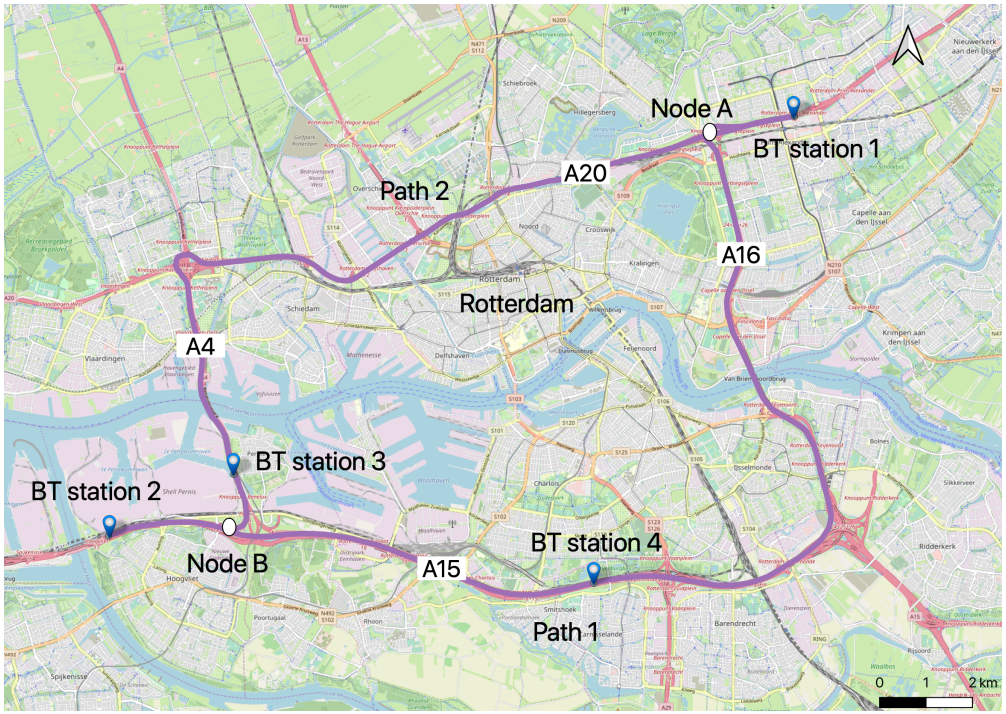
1. To model the route choices of truck drivers using Bluetooth data, loop detector data and variable message sign data

2. To evaluate the efficiencies of routing decisions of truck drivers from both user's and system's perspectives

Outline

Study area

Case study to model route choices of truck drivers between port of Rotterdam and hinterland

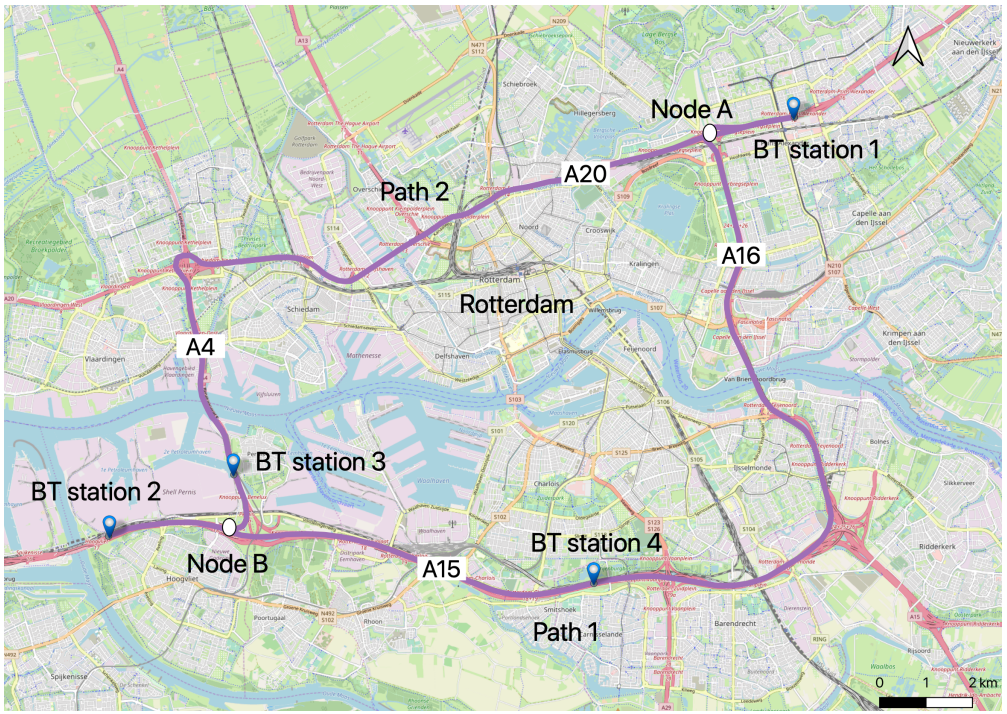


Study area: Rotterdam ring which provides a route choice for traffic destined to the port of Rotterdam

Node A as the origin and node B as the destination

Two paths: A16-A15 and A20-A4

Data collection



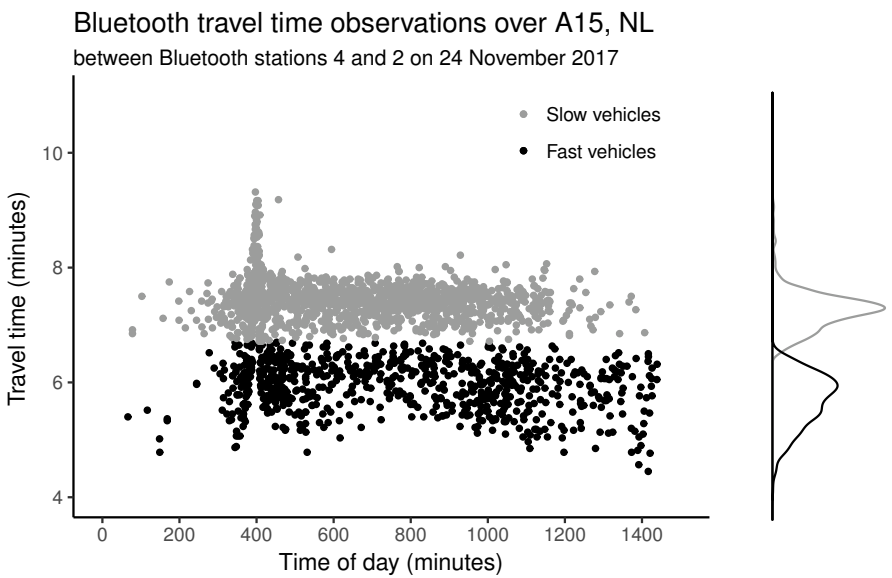
Origin-destination data: Bluetooth stations located near motorway capture the time-stamps and MAC-IDs[2] of passing vehicles

Contextual information: Travel time reliability and lane closures via loop-detector data and variable-message sign data

Bluetooth data do not provide mode classification!

[2] Media Access Control Address: unique hardware identification number

Infer trucks from Bluetooth data



Travel time clusters are formed between short segments of motorways because of differential speed limits observed in the Netherlands

Steps:

1. For the data collection period, find all the vehicles that have passed through a path and remove outliers.
2. Find the common vehicle Ids that belong to the **slow vehicle cluster** and to the path under consideration.
3. From the common vehicle Ids, select the vehicles which have traversed the path with a maximum speed of 80 km/h [3].
4. The vehicle Ids thus extracted can be **classified as trucks**

[3] 80 km/h refers to the speed limit for trucks on motorways in the Netherlands.

Model specification

Utility is specified as a linear sum of the following attributes.

- Total distance of a path (TD)
- Instantaneous travel time of a path (ITT)
- Travel time unreliability of a path ($TTUR$)
- Maximum number of lanes closed along a path (LC) as a proxy for congestion

[4] J. W. C. van Lint, H. J. van Zuylen, and H Tu (2008). "Travel time unreliability on freeways: Why measures based on variance tell only half the story". In: *Transportation Research Part A: Policy and Practice* 42.1, pp. 258–277

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$TTUR$ captures the day-to-day travel time variabilities of previous 10 working days using a skewness-based indicator[4].

$$TTUR = \frac{T_{90} - T_{50}}{T_{50} - T_{10}}$$

$TTUR$ is time of day based: morning, afternoon, evening and night.

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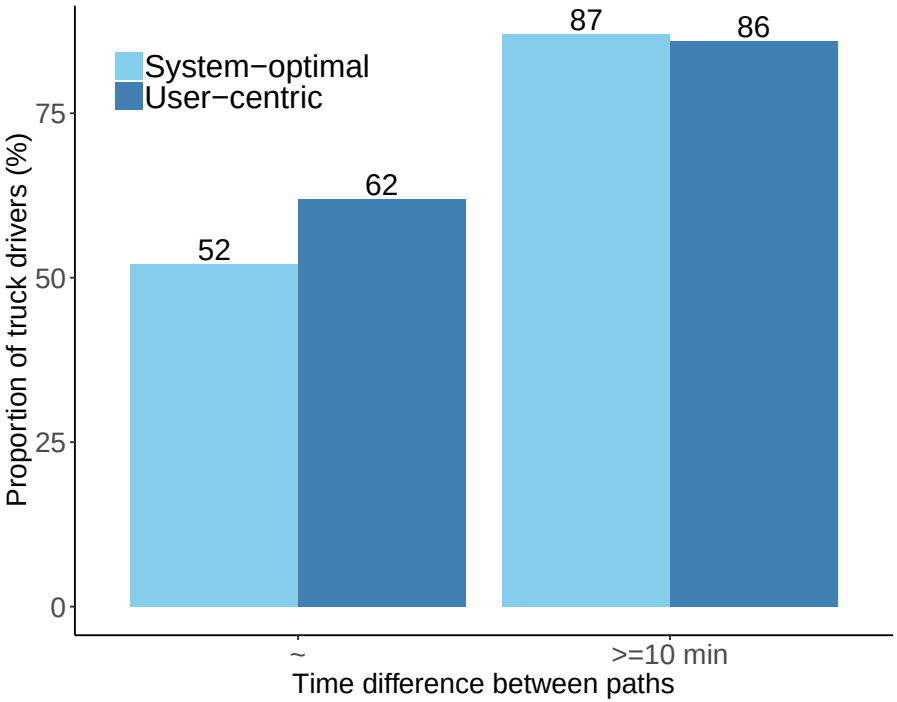
Model estimation

Parameters		Binary logit Value	Binary logit t-test	Mixed logit Value	Mixed logit t-test
ITT (min)	Mean	-0.0866	-6.39	-0.152	-4.89
	SD			0.0197	0.21
TD (km)	Mean	-0.262	-19.54	-0.463	-6.33
	SD			0.512	4.40
TTUR	Mean	-0.00594	-1.10	-0.00899	-0.98
	SD			-0.00125	-0.53
LC	Mean	-0.229	-2.36	-0.414	-2.35
	SD			-0.493	-1.03
Number of observations			1671		1671
Number of individuals			1419		1419
$\mathcal{L}(\beta_0)$			-1158.249		-1158.249
$\mathcal{L}(\hat{\beta})$			-867.758		-848.337
$\bar{\rho}^2$			0.247		0.261

Outline

Inefficiencies in routing decisions



User-centric: choose a path with least instantaneous travel time

System-optimal: choose a path with enough spare capacity and the instantaneous travel time on it should not be worse than that of shortest time path

Spare capacity of a path: We first compute section-specific density values. A path will have spare capacity if the maximum of all such density values is less than a nominal value (i.e., 25 veh/km/lane[5]).

[5] Y. Sugiyama, M. Fukui, M. Kikuchi, K. Hasebe, A. Nakayama, K. Nishinari, S.-i. Tadaki, and S. Yukawa (2008). "Traffic jams without bottlenecksexperimental evidence for the physical mechanism of the formation of a jam". In: *New journal of physics* 10.3, p. 033001

Outline

Conclusions

- We model route choices of truck drivers by combining RP dataset and contextual information.
- Truck drivers significantly value time, distance and lane closures for their on-trip routing decisions.
- The mixed logit model shows that the estimate of travel distance varies significantly in the population.
- 38% of truck drivers do not take the shortest time path and 48% do not make system-optimal routing decision.
- The routing efficiencies of truck drivers can be improved by utilizing traffic management solutions.

Next steps

- To add multiple OD pairs in the present framework
- To use GPS data as a revealed preference data source
- To identify latent classes of truck drivers

Acknowledgments