Key variables merging behaviour

Empirical comparison between two sites and assessment of gap acceptance theory

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Introduction

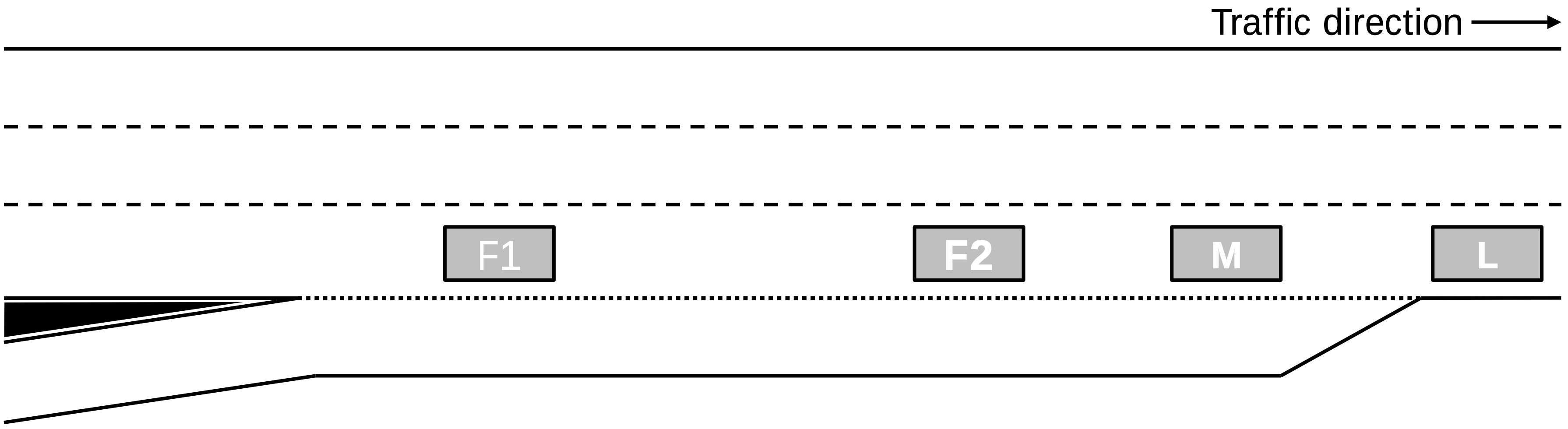
Background

- Driver behaviour at merging sections is cause of breakdowns
- Interaction between flow on main motorway and flow on acceleration lane
- Merging process part of many models
  - Gap acceptance models
  - No validation due to lack of microscopic empirical data

- Research aim
  - Improve insights into merging behaviour
  - Assess and extend existing merging models

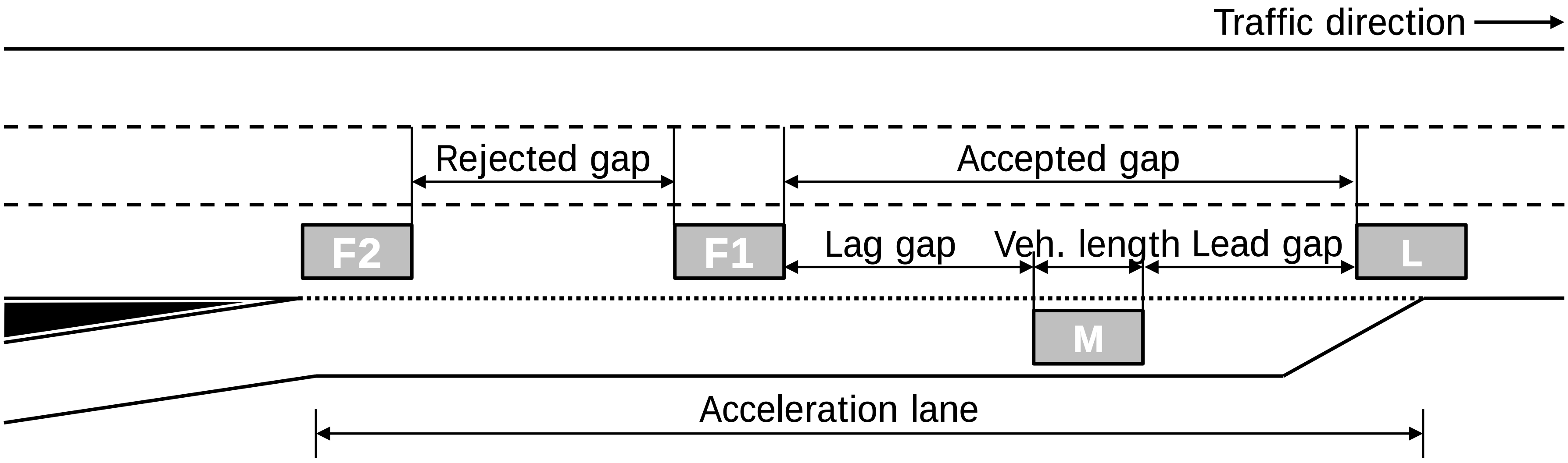
Introduction

Definitions



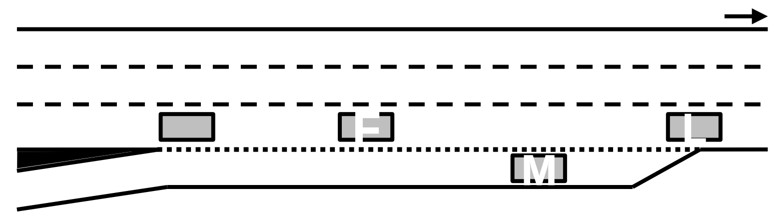
Introduction

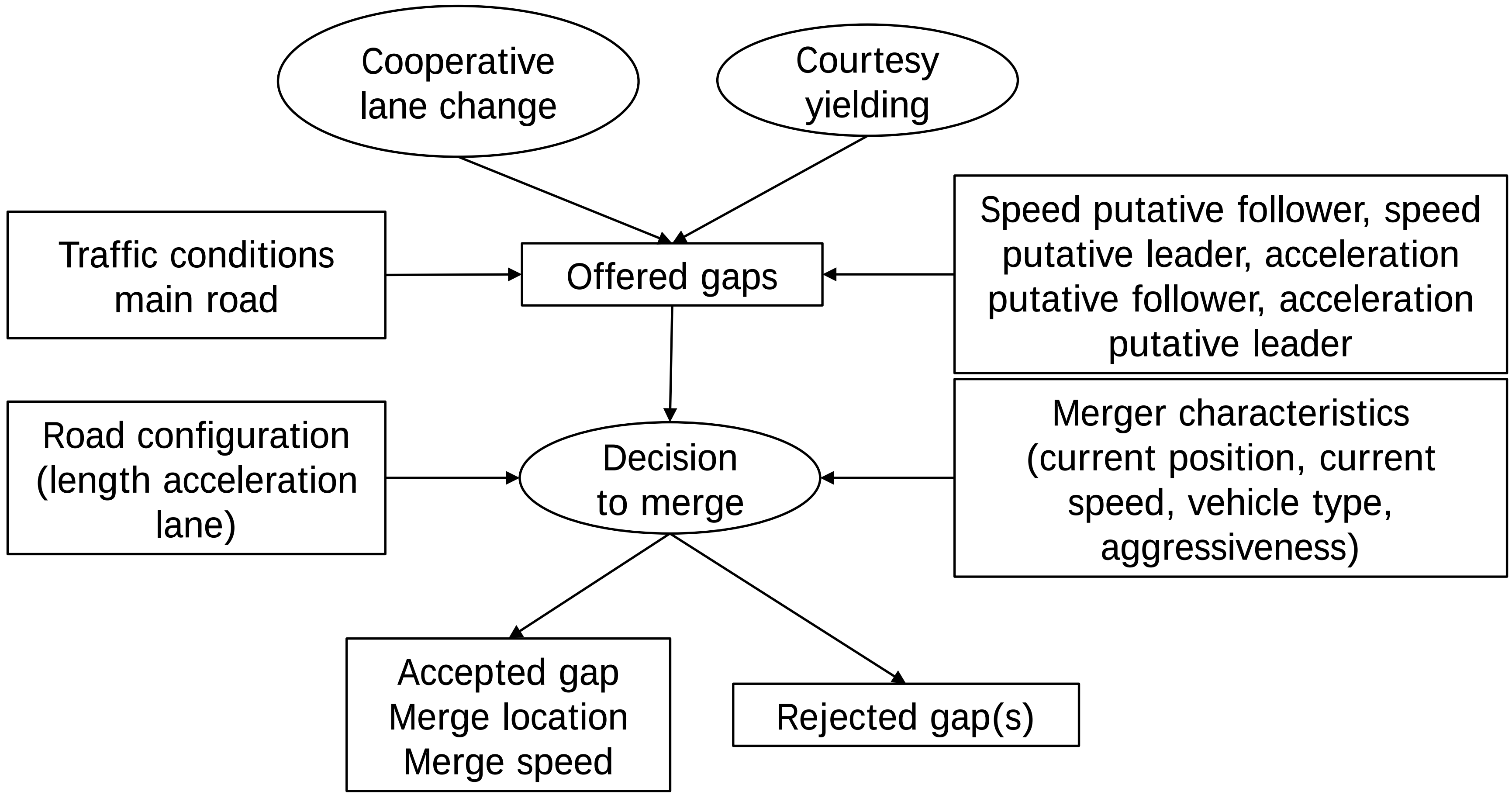
Definitions



Introduction

Conceptual model





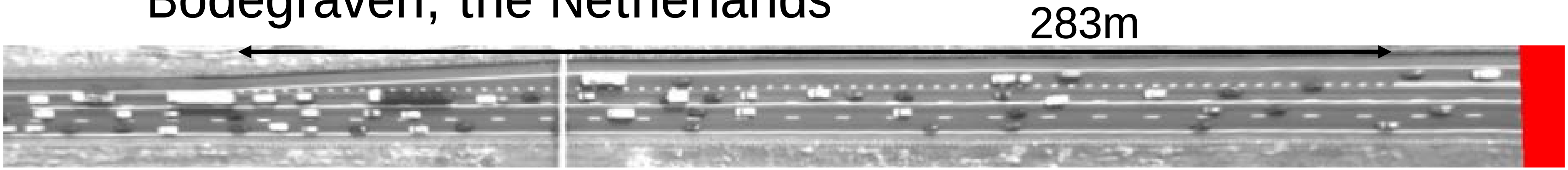
Research approach

- Empirical data analyses
  - Using microscopic trajectory data
  - On two sites
  - Finding statistical relations between merging characteristics
- Assessing principles of gap acceptance model
  - Based on trajectory data
- Developing new model
  - Based on logistic regression
  - Assess model quality for both sites

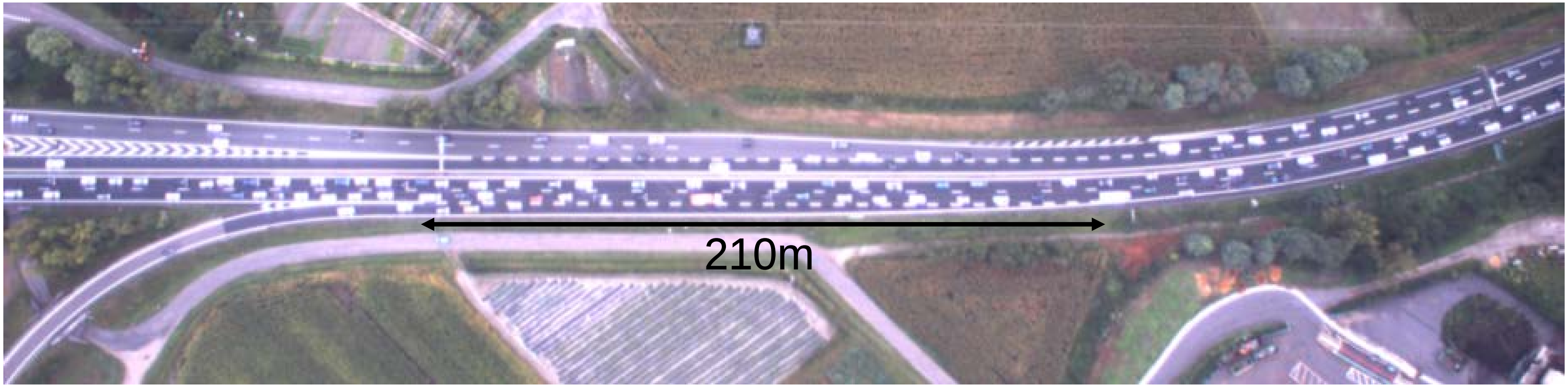
Empirical data collection

Two sites

Bodegraven, the Netherlands

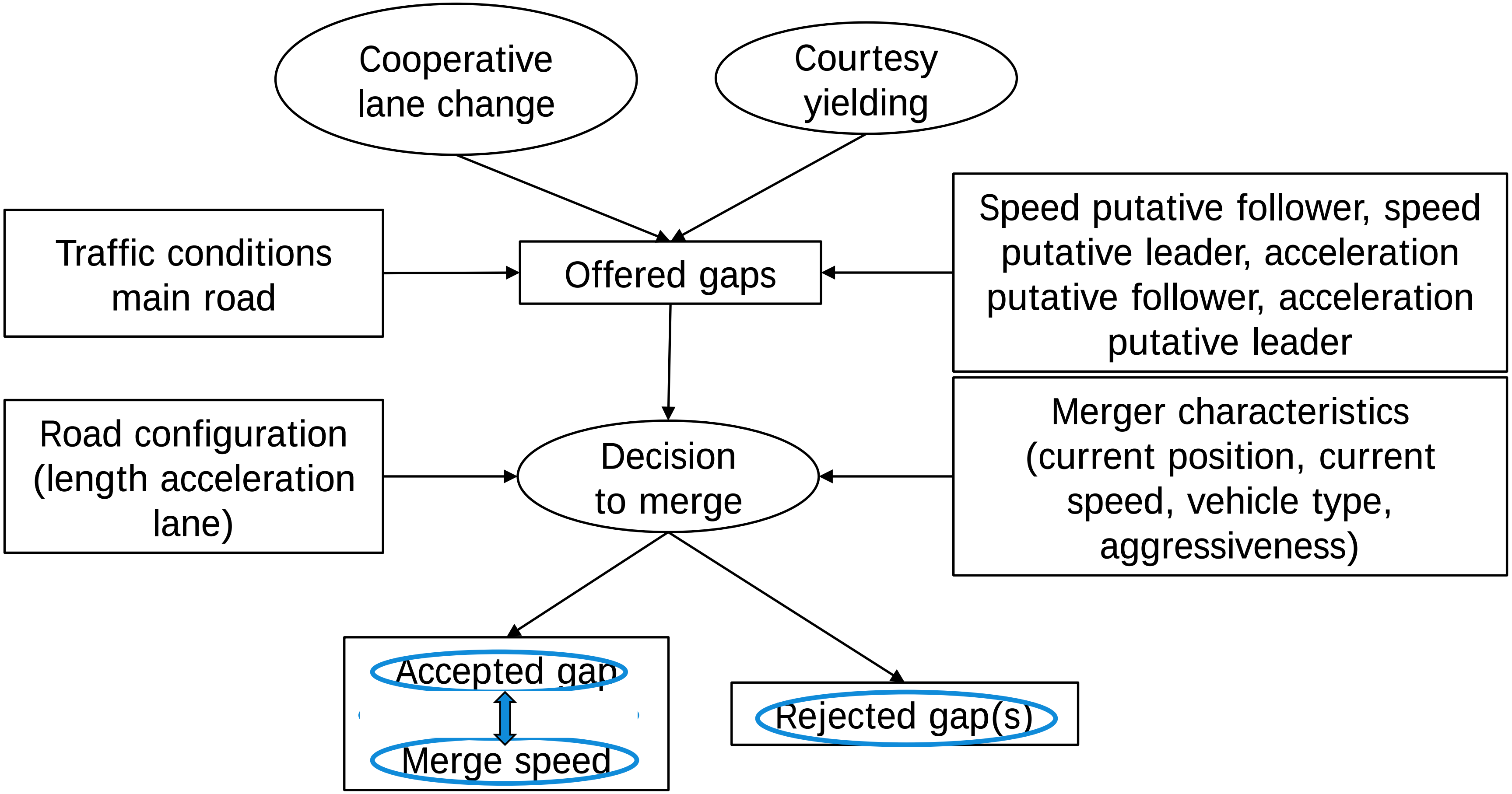


Grenoble, France (mocopo.ifsttar.fr)



Data analyses

Merging characteristics



Data analyses

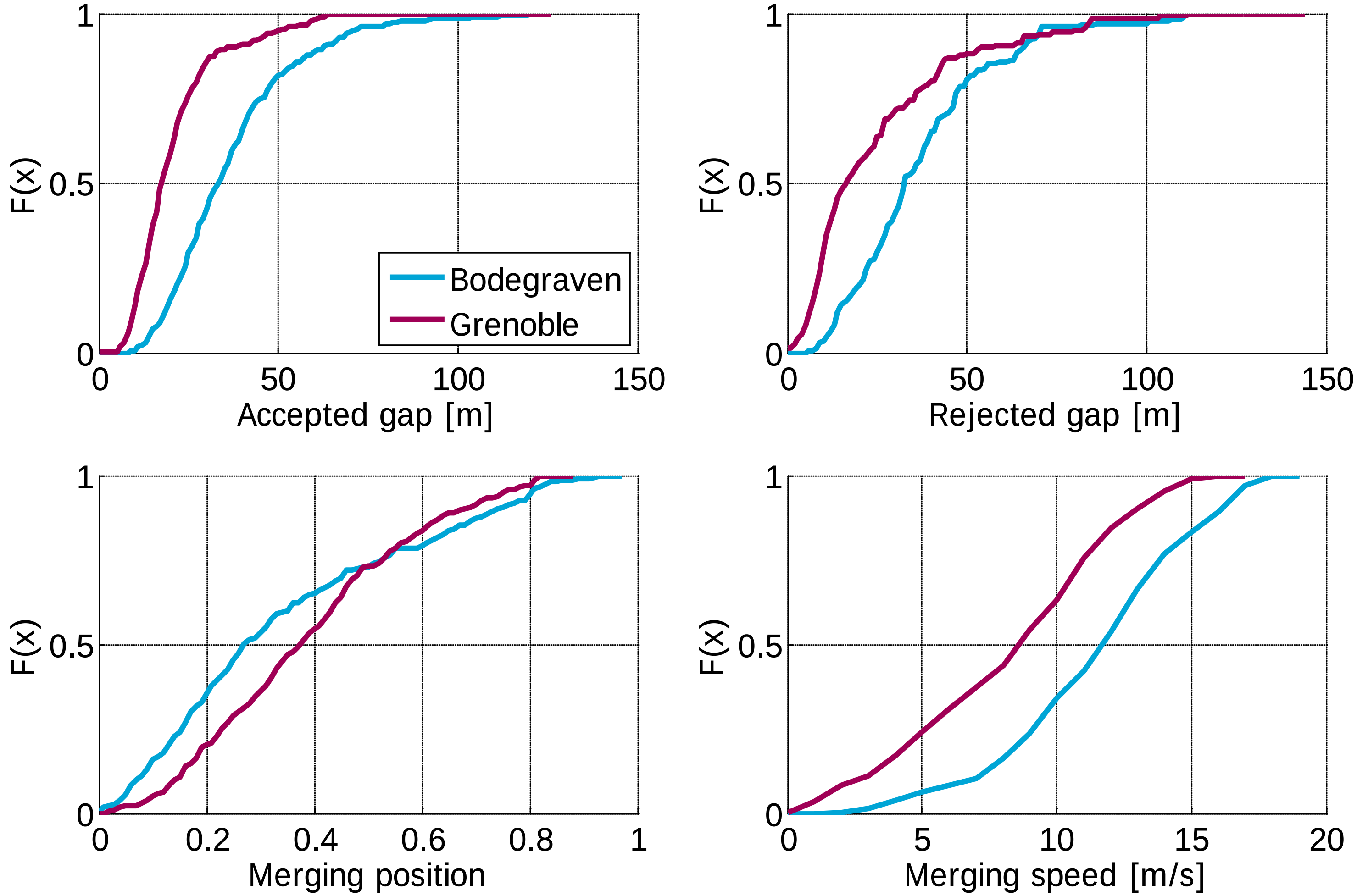
Data characteristics

- Congested traffic (speeds < 20 m/s)
- Dry weather
- Only passenger cars in Grenoble, thus no vehicle type studied

	Number of accepted gaps	Number of rejected gaps	Total
Bodegraven	377	100	477
Grenoble	242	117	359
Total	619	217	836

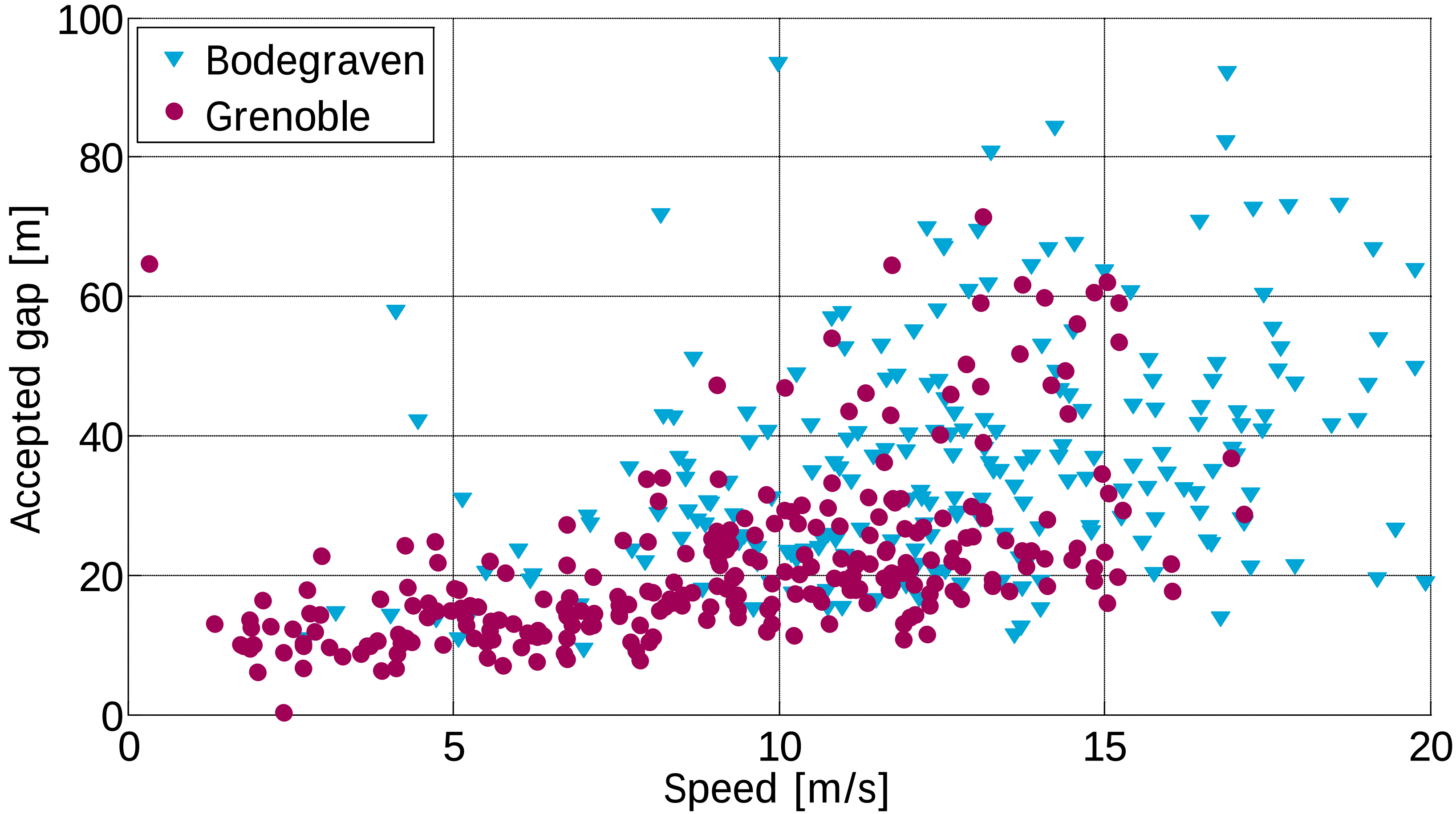
Data analyses

Descriptive statistics



Data analyses

Relation between accepted gap and merge speed



Assessing gap acceptance

Background

- If a gap is larger than a critical gap, it is accepted
- Otherwise, it is rejected

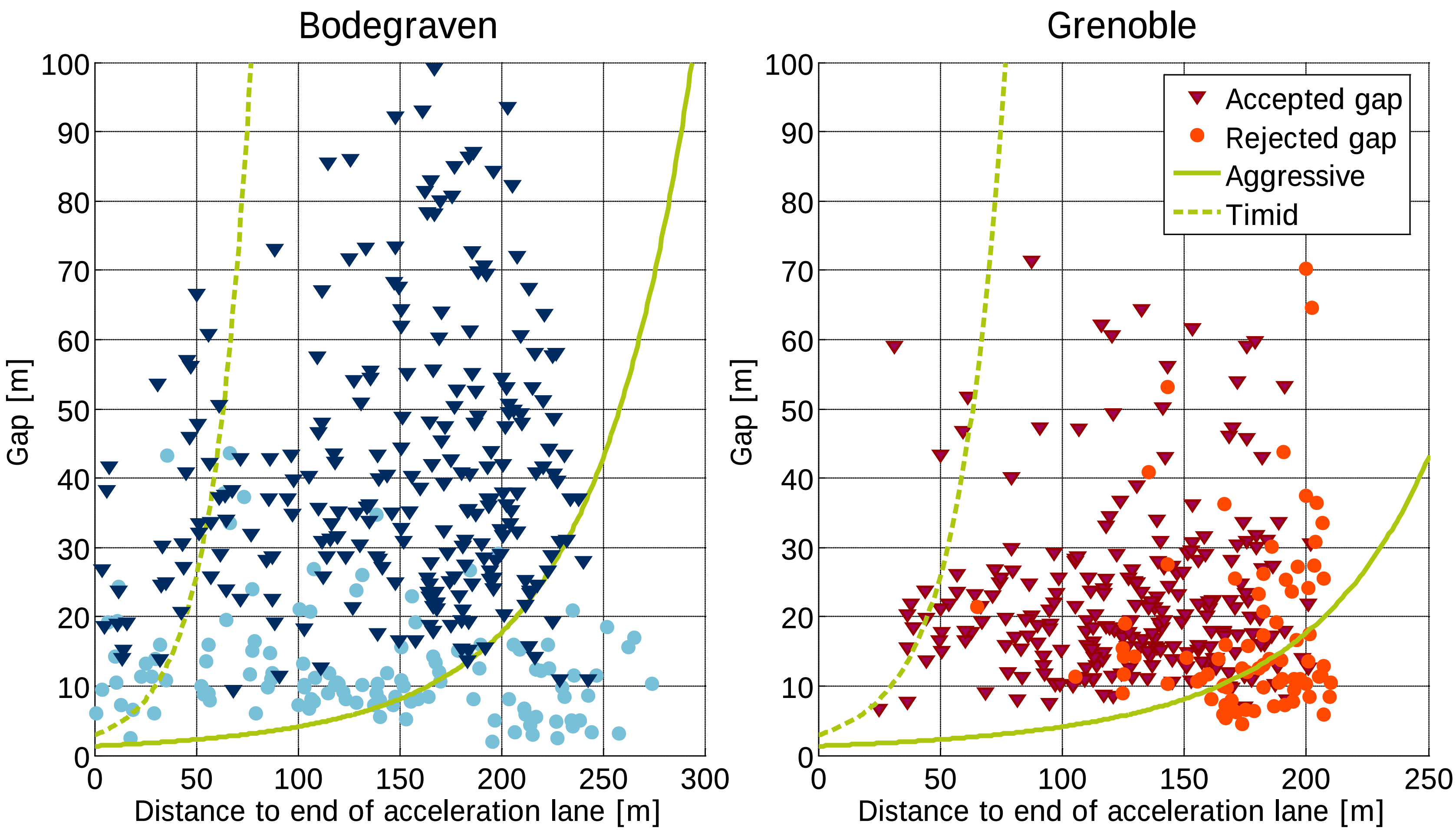
- According to literature, the critical gap may depend on
  - Speed of merging vehicle
  - Acceleration of putative following vehicle
  - Remaining distance on acceleration lane
  - ...

$$G_{nt}^{iLag} = \exp\left(\begin{array}{l} \gamma^{ilag} + \dfrac{0.439}{1+\exp\left(0.0242+0.00018\upsilon_n\right)} d_{nt} + 0.208 Max\left(0, \Delta V_{nt}^{lag}\right) \\ +0.184 Min\left(0, \Delta V_{nt}^{lag}\right) + 0.0545 Max\left(0, a_{nt}^{lag}\right) + \alpha_{nt}^{ilag} \upsilon_n + \varepsilon_{nt}^{ilag} \end{array} \right)$$

From Choudhury et al. (2007)

Assessing gap acceptance

Using critical gap thresholds by Choudhury et al. (2007)



New merging model

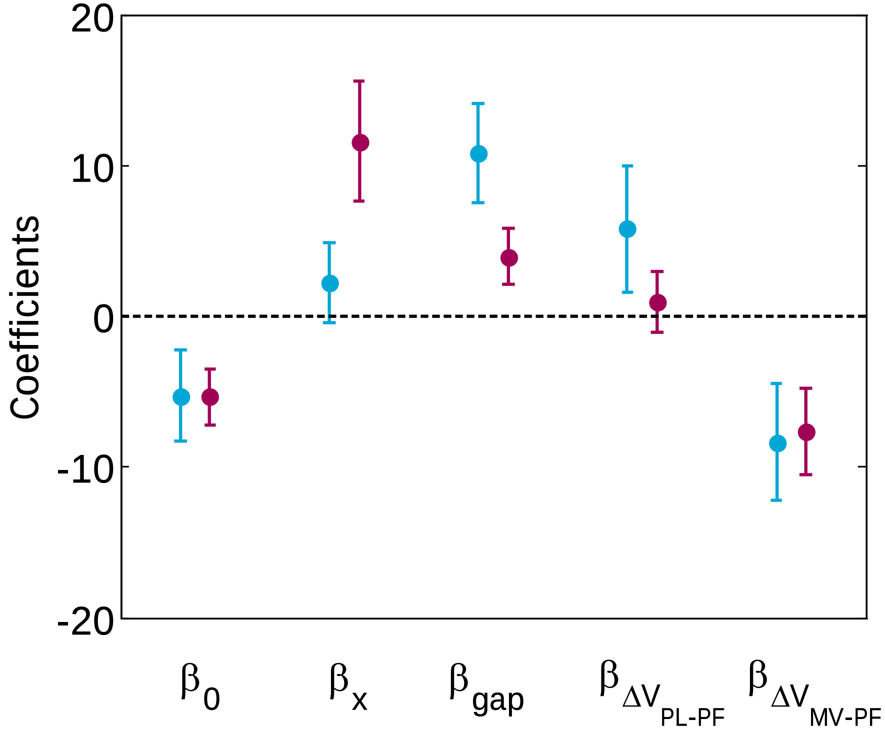
Introduction

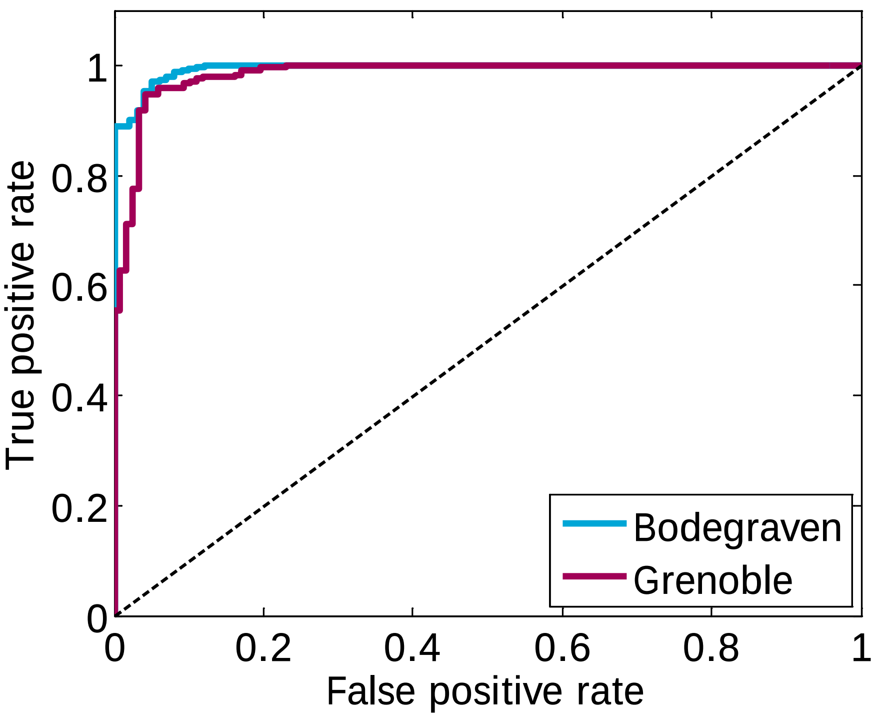
- Principal Component Analysis applied
- Most contributing variables
  - position on acceleration lane
  - offered gap (length in meters)
  - speed difference between putative leader and putative follower
  - speed difference between merging vehicle and putative follower
- Generalised linear model
  - To quantify influencing factors on probability whether drivers accept or reject a certain gap
- Explanatory variables are normalized to establish a comparison
- Use logit function to quantify

New merging model

All factors included

$$\ln \frac{p(1|X)}{1-p(1|X)} = \beta_0 + \beta_x X_{pos} + \beta_{gap} X_{gap} + \beta_{\Delta V_{PL-PF}} X_{\Delta V_{PL-PF}} + \beta_{\Delta V_{MV-PF}} X_{\Delta V_{MV-PF}}$$

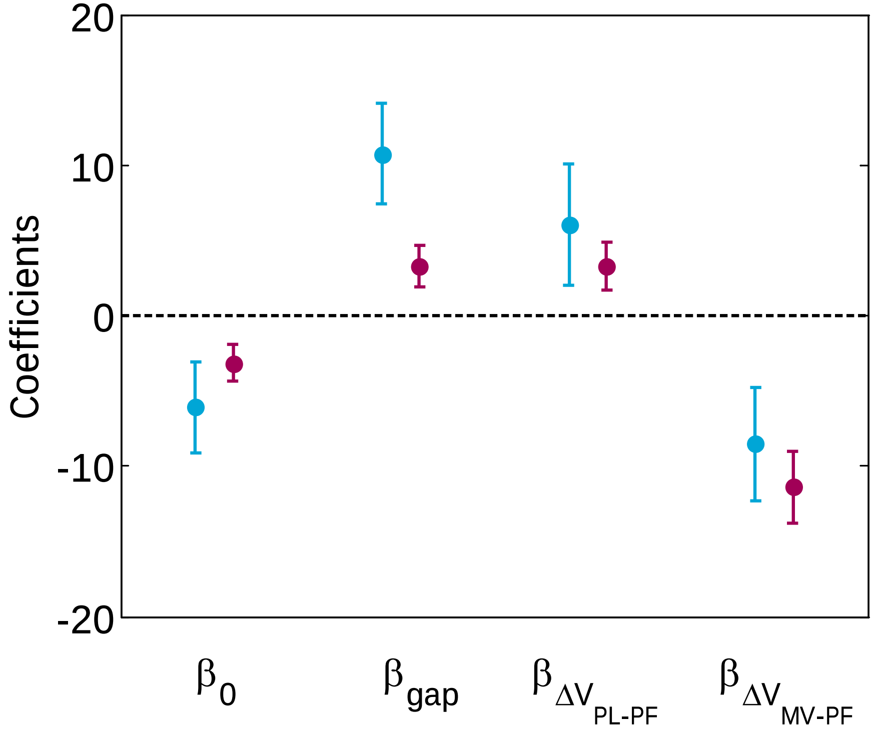


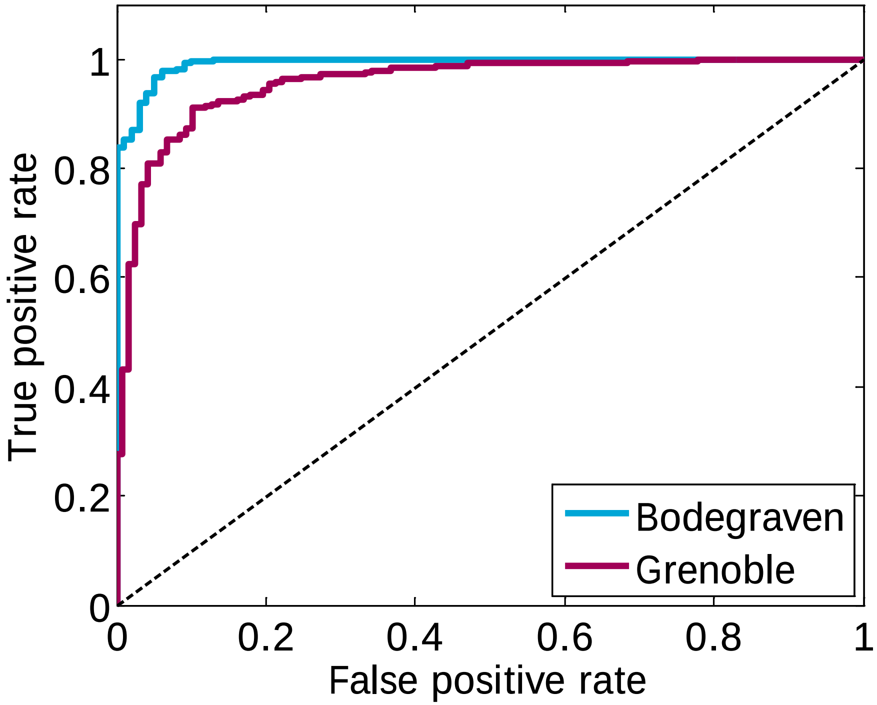


New merging model

Without position of gap on acceleration lane

$$\ln \frac{p(1|X)}{1 - p(1|X)} = \beta_0 + \beta_{gap} X_{gap} + \beta_{\Delta V_{PL-PF}} X_{\Delta V_{PL-PF}} + \beta_{\Delta V_{MV-PF}} X_{\Delta V_{MV-PF}}$$

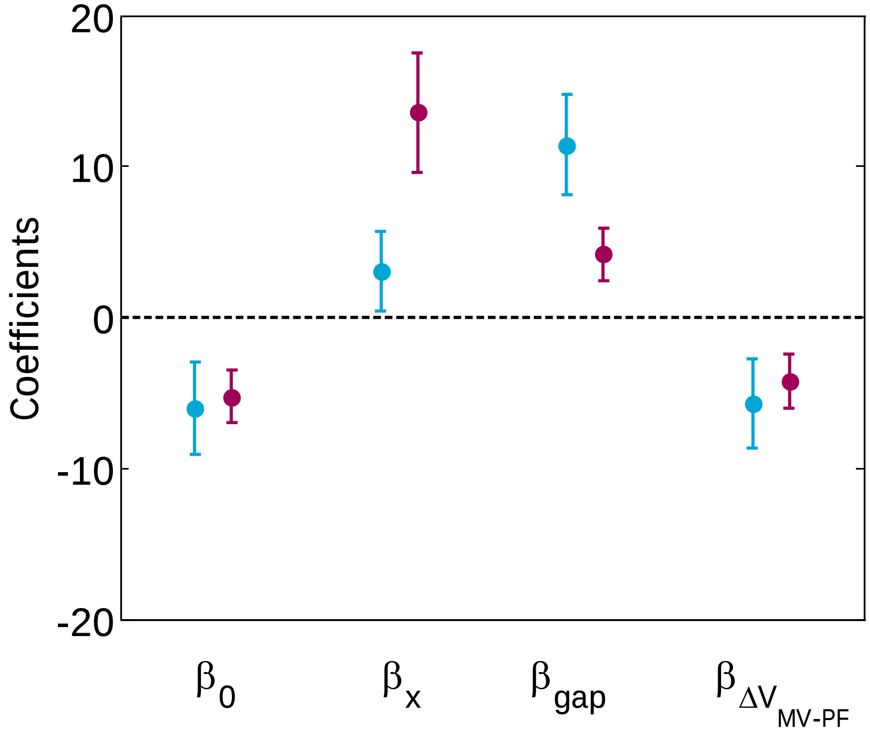


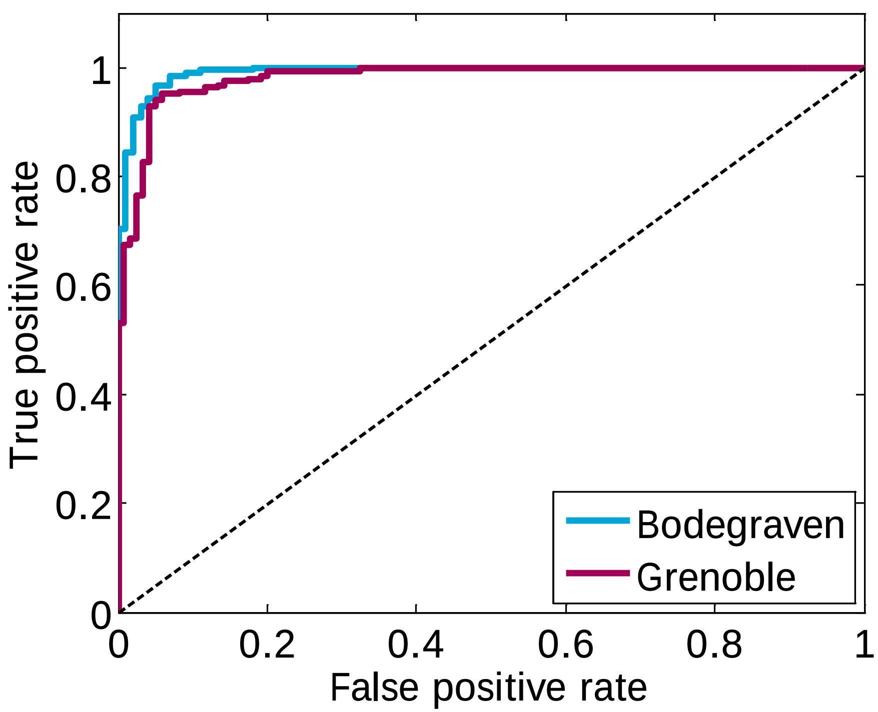


New merging model

Without speed difference between putative leader and follower

$$\ln \frac{p(1|X)}{1 - p(1|X)} = \beta_0 + \beta_x X_{pos} + \beta_{gap} X_{gap} + \beta_{\Delta V_{MV-PF}} X_{\Delta V_{MV-PF}}$$





Conclusions and future research

- Comparative analysis of merging behaviour on motorways
- Differences at two locations
  - Different geometric configuration
  - Different traffic conditions (more severe congestion in Grenoble)
- Assessment of gap acceptance model
  - No boundary similar to critical gap could be found
- Proposal of new stochastic model
  - Statistically significant set of variables
  - Logistic regression analysis with strong predictive power

- Future research
  - Study other locations
  - Validate model in other situations