Driver Behaviour Prediction at Roundabouts: Results from a Field Study

Min Zhao
E-Mail: min.zhao@dlr.de
Deutsches Zentrum für Luft- und Raumfahrt (DLR), Institut für Verkehrssystemtechnik, 38108 Braunschweig
Agenda

1. Motivation and objective
2. State of the art
3. Methodology
4. Field study and results
   • data preprocessing
   • data exploration and behaviour classification
5. Conclusion and future work
Motivation

Roundabouts:

- Increasing number of roundabouts
- Crashes at roundabouts

Objective

driver behaviour prediction:

take the exit or not
State of the art

driver behaviour at section:

longitudinal control behaviour (lane changing/car-following)
- Hidden Markov Model (Pentland, 2000)
- machine learning techniques (Tango, 2009)
- Bayesian programming (Möbus, 2009)

driver behaviour at intersection:

decision estimation
- Bayesian network (Lefèvre, 2011)
- K-means clustering (Naito, 2010)
- Hidden Markov Model (Gadepally, 2014)
Methodology

- Literature of driving behaviour
- Field study
- Data analysis and exploration
- Hypothesis
  - Simulator study
  - Model validation
  - Prediction model
  - Machine learning
Field study

- seven participants
- ViewCar equipment
- Standardized driving route
Data preprocessing

data selection:
Data preprocessing

error data removal:
Classification with Support Vector Machine

possible variables:
- velocity, acceleration
- indicator
- location
- yaw
- steering angle
- steering angle speed
- head motion, eye motion
Classification with Support Vector Machine

When entrance and exit are adjacent:

type 1

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type 2
Classification with Support Vector Machine

When entrance and exit are **not** adjacent:

- **type 3**
Classification with Support Vector Machine

result of prediction for type 1:

<table>
<thead>
<tr>
<th>label_test</th>
<th>label_prediction</th>
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<tbody>
<tr>
<td>staying</td>
<td>42</td>
</tr>
<tr>
<td>leaving</td>
<td>2</td>
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hit rate: 95.45% staying, 100% leaving
Classification with Support Vector Machine

result of prediction for type 2:

<table>
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<tr>
<td>Staying</td>
<td>38</td>
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<tr>
<td>leaving</td>
<td>1</td>
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<tr>
<td>hit rate</td>
<td>95.00%</td>
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10.28 m, 1.62 s
Classification with Support Vector Machine

result of prediction for type 3:

<table>
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<tbody>
<tr>
<td>staying</td>
<td>leaving</td>
</tr>
<tr>
<td>staying</td>
<td>40</td>
</tr>
<tr>
<td>leaving</td>
<td>5</td>
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<tr>
<td>hit rate</td>
<td>88.89%</td>
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12.11 m, 1.90 s
Summary of the field study:

- status of steering wheel for prediction
- prediction accuracy – above 90%, c.a. 10 m away from exit

Open questions

- Online prediction
- Driver behaviours ↔ roundabout geometry

Future work:

- Hidden Markov Models for behavior prediction
- Simulator study
Simulator study design

roundabout geometry:
- angle between exits (3-arm, 4-arm)
- diameter (25 m, 40 m)
Simulator study design

take the 3rd exit

take the 4th exit
Thanks for your attention!