Determining the influence of high volumes of bicycle traffic on motorized traffic at signalized intersections in Germany – conceptual approach

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- Project objectives and tasks
- Working plan
- Conclusion & future prospects

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Project details

Diesem Bericht liegen Teile der im Auftrag des Bundesministeriums für Verkehr und digitale Infrastruktur, vertreten durch die Bundesanstalt für Straßenwesen unter FE-Nr. 70.0925/2015 durchgeführten Forschungsarbeiten zugrunde. Die Verantwortung für den Inhalt liegt allein beim Autor.

This report is based on parts of the research project carried out at the request of the Federal Ministry of Transport and Digital Infrastructure, represented by the Federal Highway Research Institute, under research project No. 70.0925/2015. The author is solely responsible for the content.

- Project duration: 01 / 2017 – 03 / 2019
- Project partners
  - Technische Universität München
  - BSV GmbH
  - DLR
  - BEUTH Hochschule Berlin

Introduction

Bicycling is becoming more important in urban areas, but this increase may lead to:

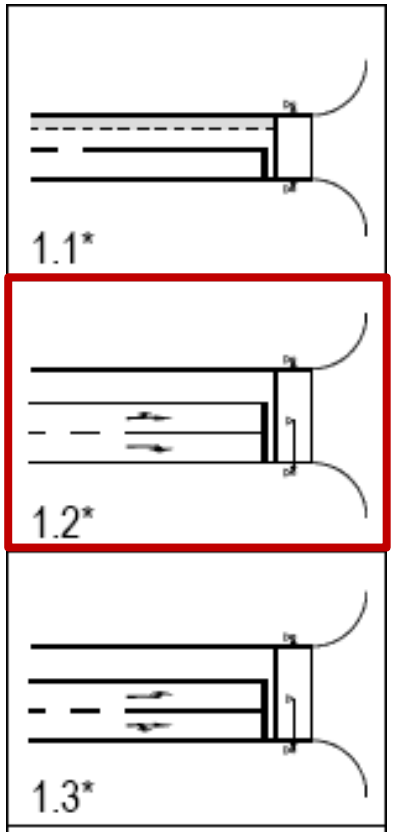
- Bicycle congestion at signalized intersections
- Performance problems for motorized traffic
- inefficient, environmentally unfriendly, unsafe traffic
- increased aggression, rule breaking behavior, and other psychological effects

Policies regulate bicycle infrastructure design and signalization for safe traffic while maintaining efficient motorized traffic flow. However:

- not all available bicycle infrastructure designs are considered in Germany
- existing method is not suitable for a high volumes of bicycle traffic
- drawbacks must be avoided (see above)
- the limits of current infrastructure design and signalization must be quantified
- a novel evaluation methodology must be identified and defined
- efficient and safe conditions must be ensured for all traffic participants

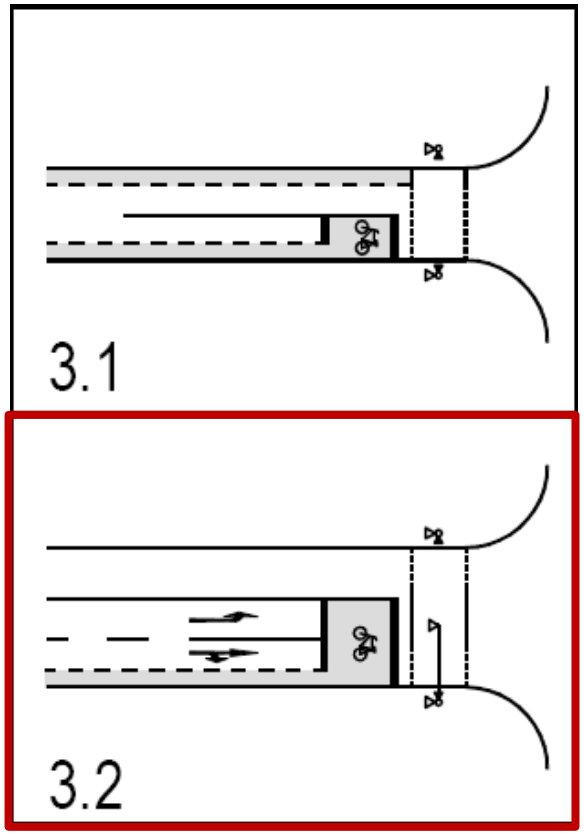
Introduction

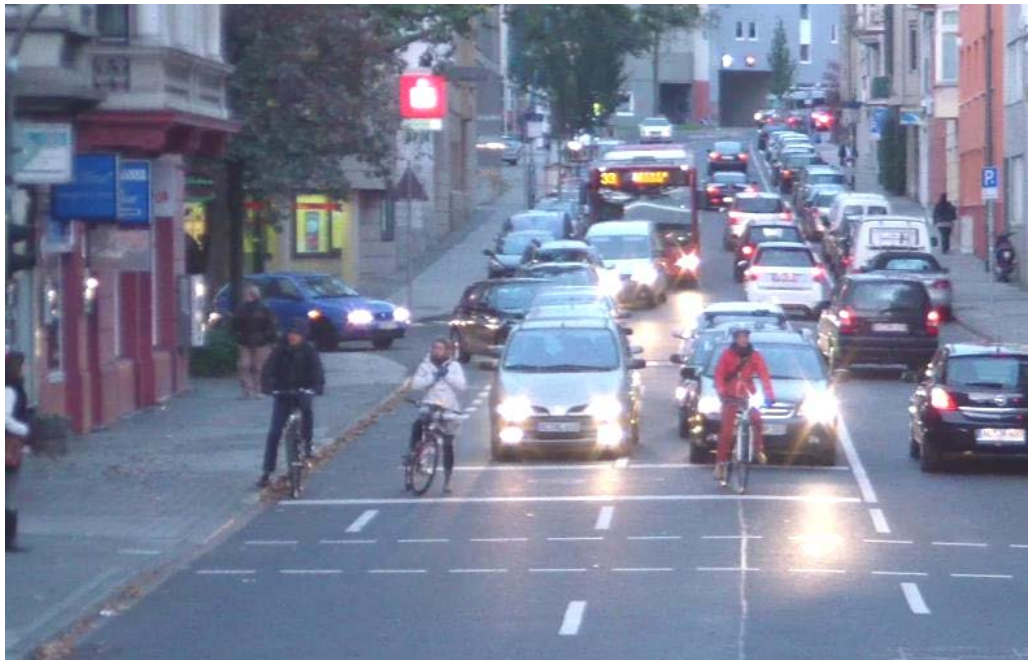
Examples 1



- no cycling infrastructure
- no queuing area
- shared signalization with motorized traffic
- Bicycles must pass waiting vehicles

Introduction
Examples 2

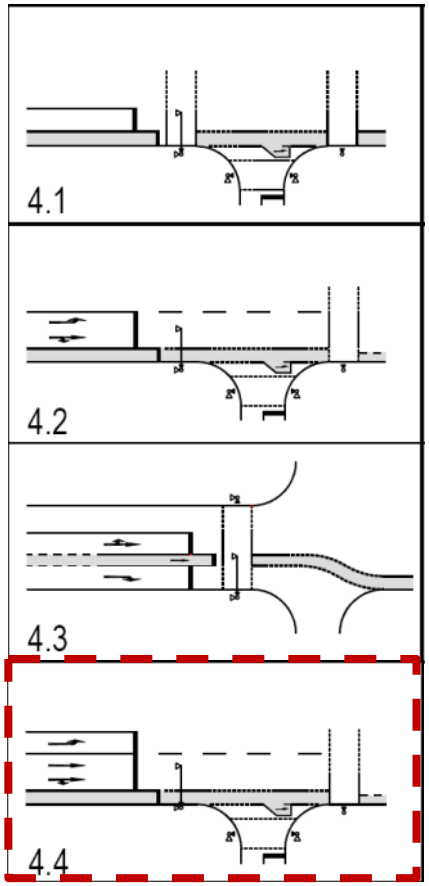




- Bicycle lane with <u>enlarged</u> upstream queuing area
- Shared signalization with motorized traffic

Introduction

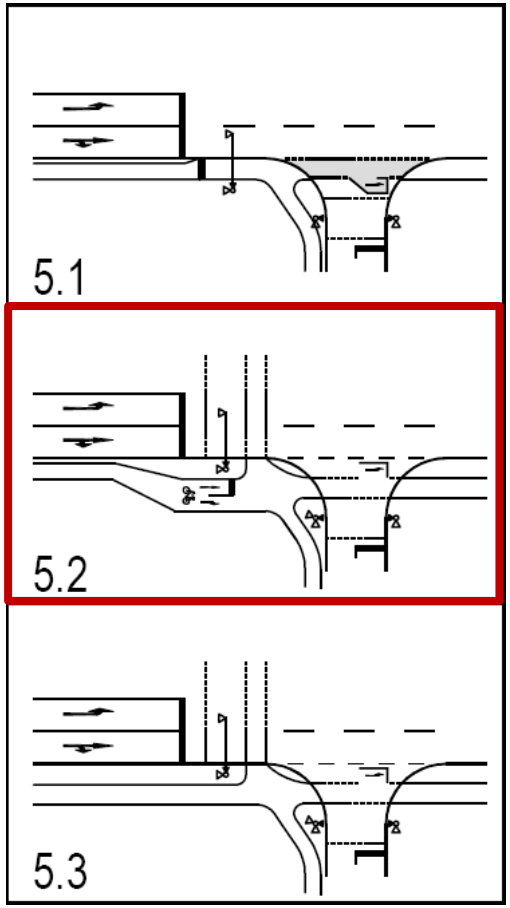
Examples 3



- Bicycle lane with upstream queuing area
- Shared or separated signalization with motorized traffic
- Indirect left turning for bicycles

Introduction

Examples 4



- Cycle path with upstream queuing area
- Shared or separated signalization with motorized traffic
- Indirect left turning for bicycles

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Project objectives and tasks

- Analysis of established evaluation methodology for capacity and traffic quality at signalized intersections for different bicycle traffic volumes, infrastructure designs and signalization
- Extension of existing methodology for high bicycle traffic volumes on the basis of empirical and simulation based studies
- Development of novel approaches for specific bicycle infrastructure designs and signalizations
- Calibration and validation of the new evaluation methodology for German conditions
- Determination of application limits of different bicycle infrastructure designs and signalization

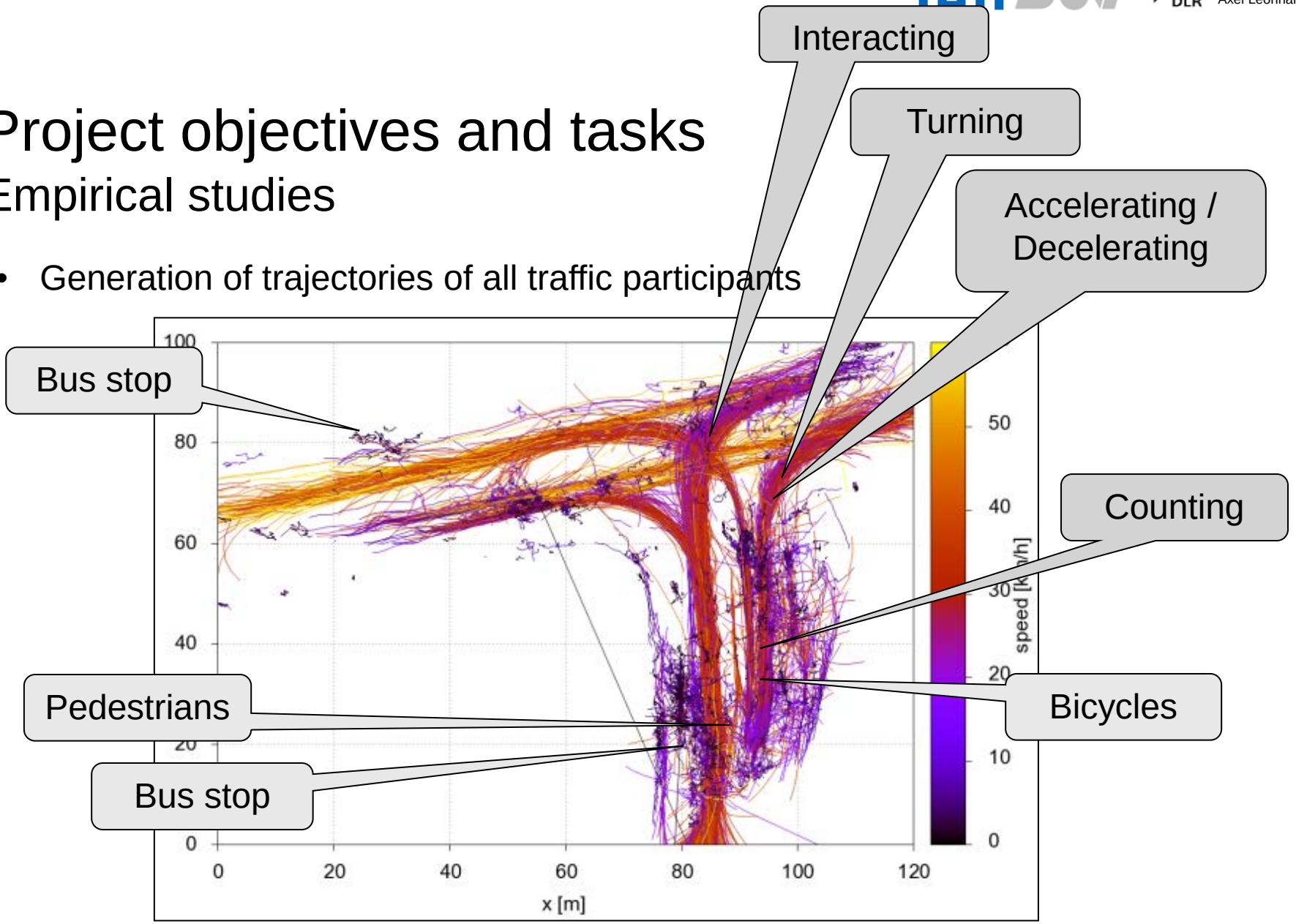
→ We need empirical data of traffic participants (microscopic and macroscopic)!

→ We need simulation!

Project objectives and tasks

Empirical studies

- Generation of trajectories of all traffic participants



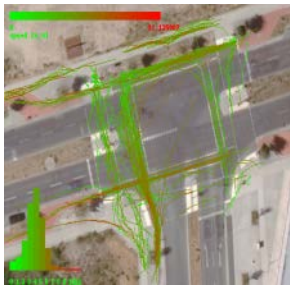
Project objectives and tasks

Empirical studies

- Process chain: object detection → classification → tracking → trajectories

1 2 3 4 5






1. Video server provides video data
2. Object detection and classification
3. Trajectory generation due to tracking
4. Computation and assessment of traffic related parameters
5. Storing data and event triggering

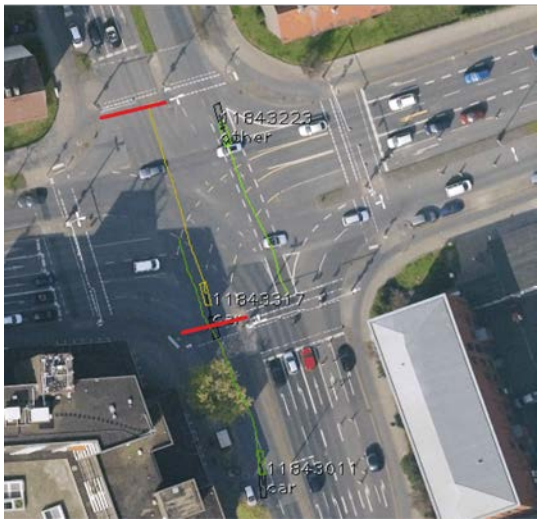
Project objectives and tasks

Empirical studies

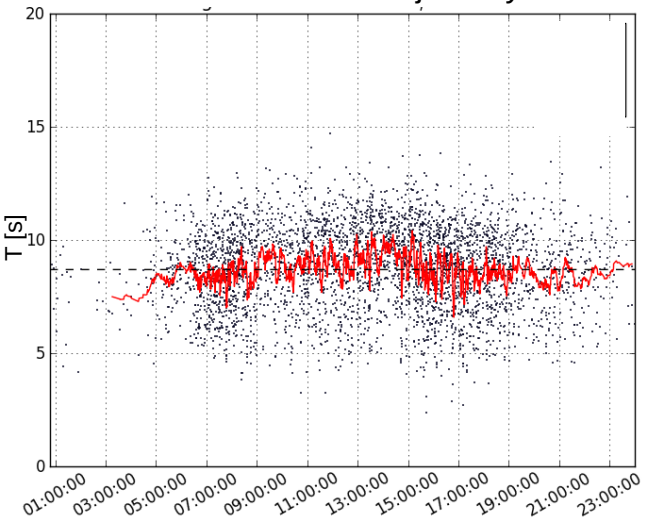
- Traffic flow related parameter determination:
  - Journey and waiting times
  - Traffic volume (motorized traffic and bicycles)
  - Distances to stop line
  - Time gaps, time loss
  - Acceleration / deceleration
  - Probability density functions (of significant parameters)
  - …

Traffic situation

Optical loops

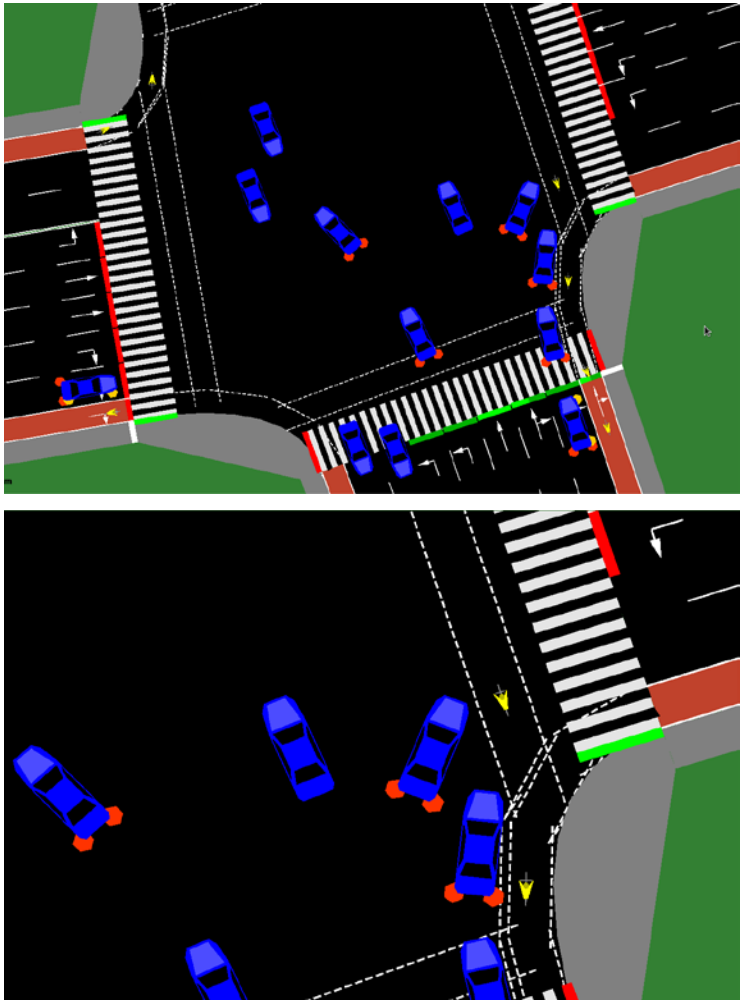


Time variation curve for journey time



Project objectives and tasks
Simulation

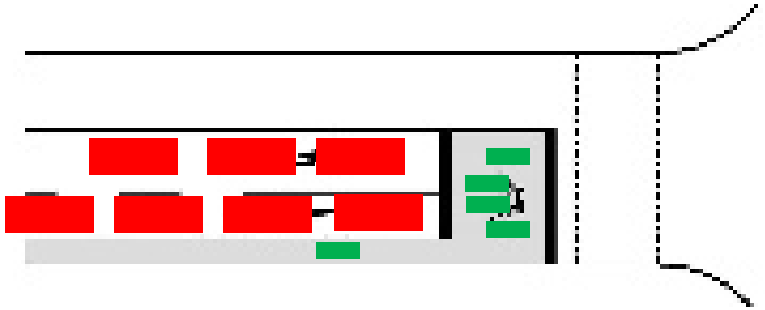
- SUMO is an open source software for microscopic and mesoscopic road traffic simulation
- Developed by DLR (Institute of Transportation Systems) and countless world wide contributions
- Ability and flexibility to model and simulate relevant infrastructure designs and signalizations as well as easy configurations of all relevant traffic participants
- Targeted creation and analysis of specific traffic situations by the TraCI interface
- SUMO provides sublane model for realistic driving behavior of bicycles



Simulation of traffic with bicyclists at a complex intersection

Project objectives and tasks

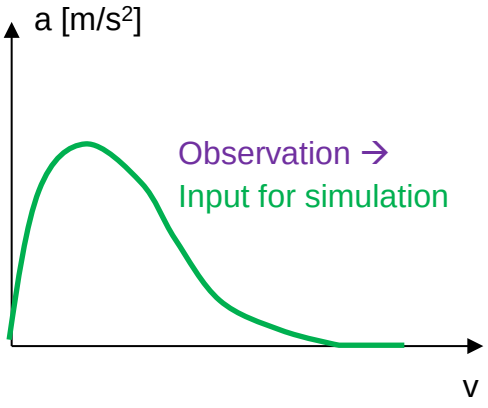
Simulation

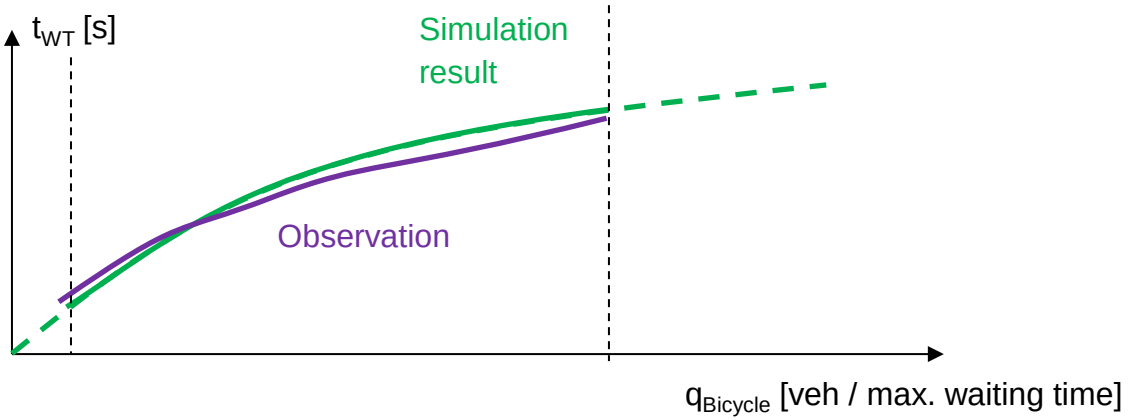


1) Calibration of driving behavior
Parameter setting on the basis of microscopic information
e.g.: acceleration and car-following behavior

2) Validation with regard to parameters
Check if the parameters are in line with empirical data
e.g. capacity, occupancy time, maximum waiting time

3) Quality control and plausibility check, particularly for situations and ranges, where no empirical data is present





Project objectives and tasks
Evaluation methodology

- Enhance existing or define a novel evaluation methodology for different bicycle infrastructure designs
  - bicycle paths
  - bicycle lanes
  - mixed urban traffic with or without bicycle lanes
  - partially compatible left turning traffic flows
  - indirect left turning bicycle traffic

→ (international) literature survey

→ knowledge from results of empirical studies and simulations

→ quantify specific adjustment factors of known connections of heavy traffic on bicycle traffic

→ quantify occupancy time given the bicycle traffic volume

Project objectives and tasks
Documentation

- Providing explanation of the proposed evaluation methodology for official policies
- Designing the blank forms of the policy document
- Contributing examples (one for each bicycle infrastructure design)
  - Visualization of the situation (map, signalization, traffic load)
  - Brief task description
  - Sample solution that can be included in the official policy documents
- Verification of these results by relevant test users (engineering offices, local authorities, traffic planners), which give feedback on the basis of questionnaires

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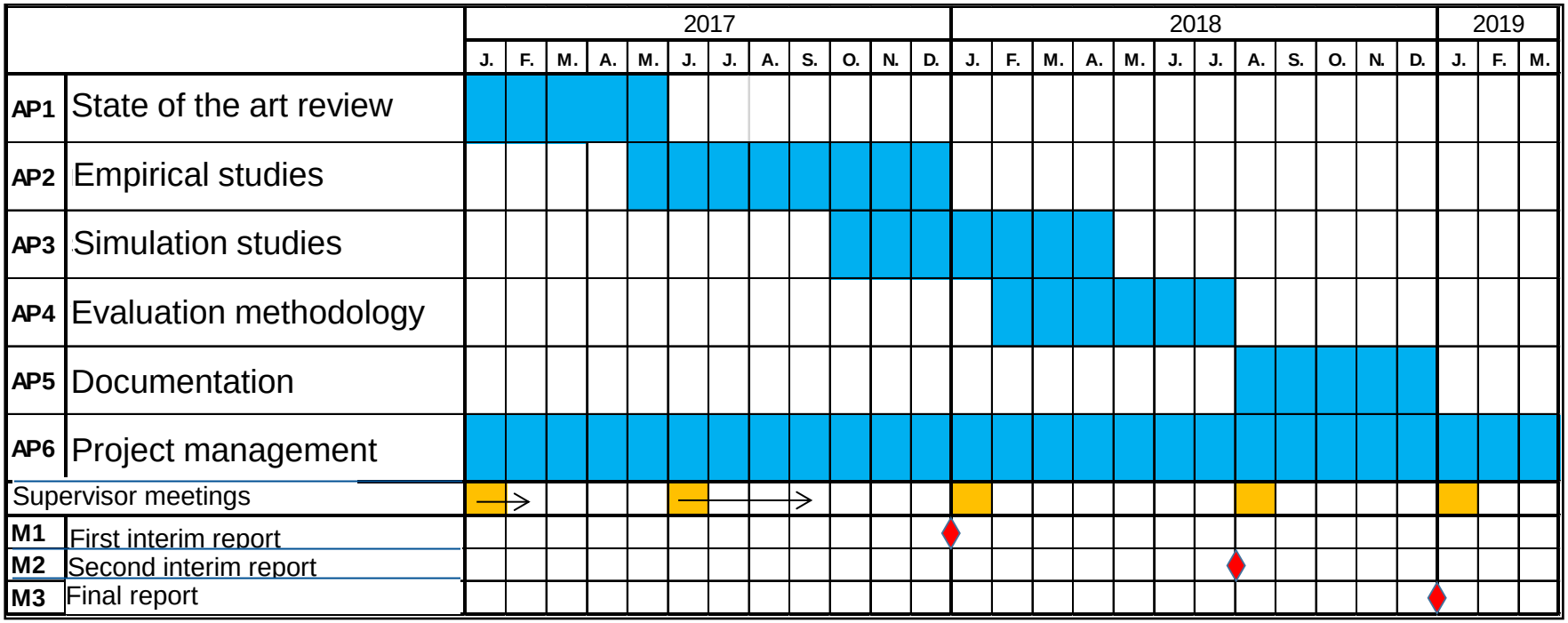
Working plan

Project plan, milestones, supervisor meetings



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Conclusions & Future prospects

Conclusions

- Multidisciplinary project connecting empirical and simulation studies on the basis of traffic object trajectory data and microscopic traffic simulations with SUMO
- Analysis of 6 intersections with different infrastructure and signalizations in Berlin, Munich and Freiburg
- Empirical findings about how bicyclists behave when using different infrastructure designs and signalizations
- Simulation based findings of the capacity of bicycle infrastructure

Future prospects

- Getting permission for the planned data collection campaigns
- Conducting of these campaigns, data processing and evaluation
- Starting the simulation work package

Thank you for your attention!

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