

Long-Term Analysis of Driver Behaviour in the Dilemma Zone at a Signalized Intersection



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Problem

- High risk of accidents in the yellow interval, where vehicles enter the dilemma zone (DZ) [1]
- Traffic behaviour in the DZ has been studied, but day vs. night differences remain unexplored [2]

Solution

- Use high-resolution trajectory data from AIM Research Intersection [3] to quantify night vs. day driving behaviour

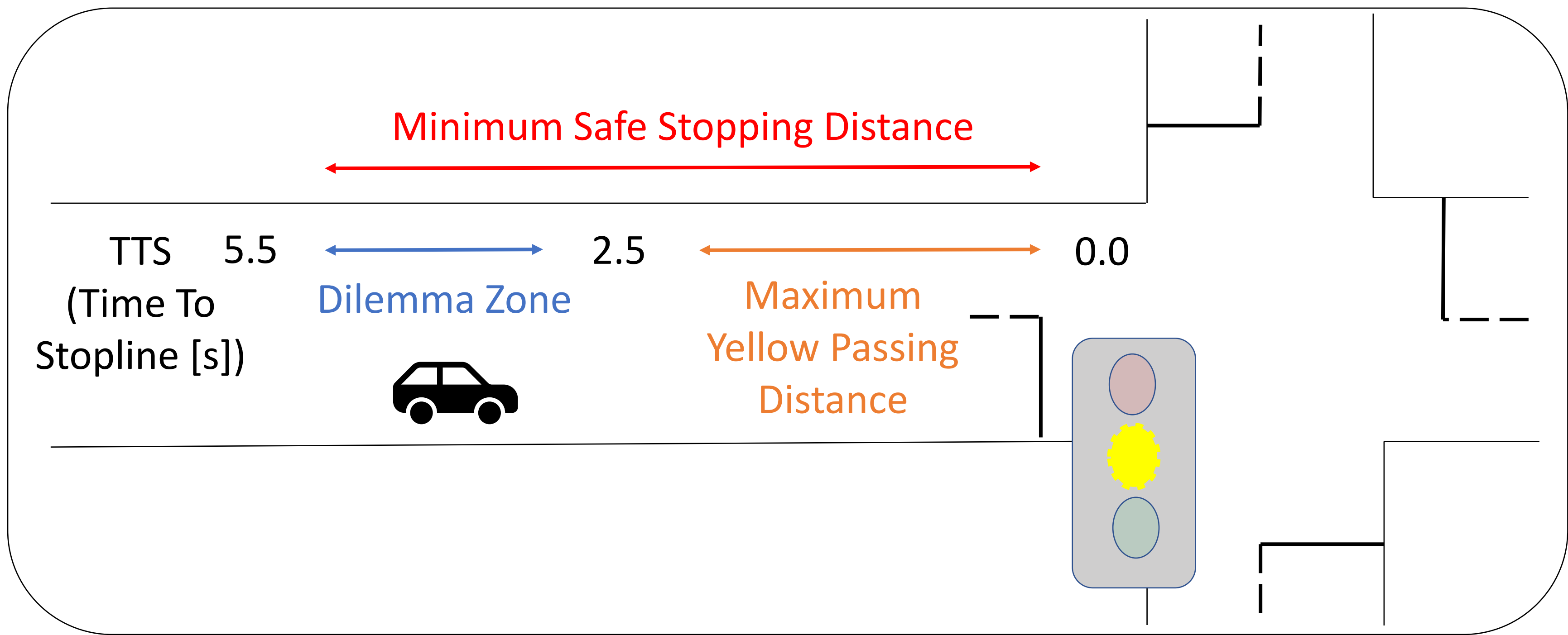


Figure 1: Symbolic representation of dilemma zone according to [2].

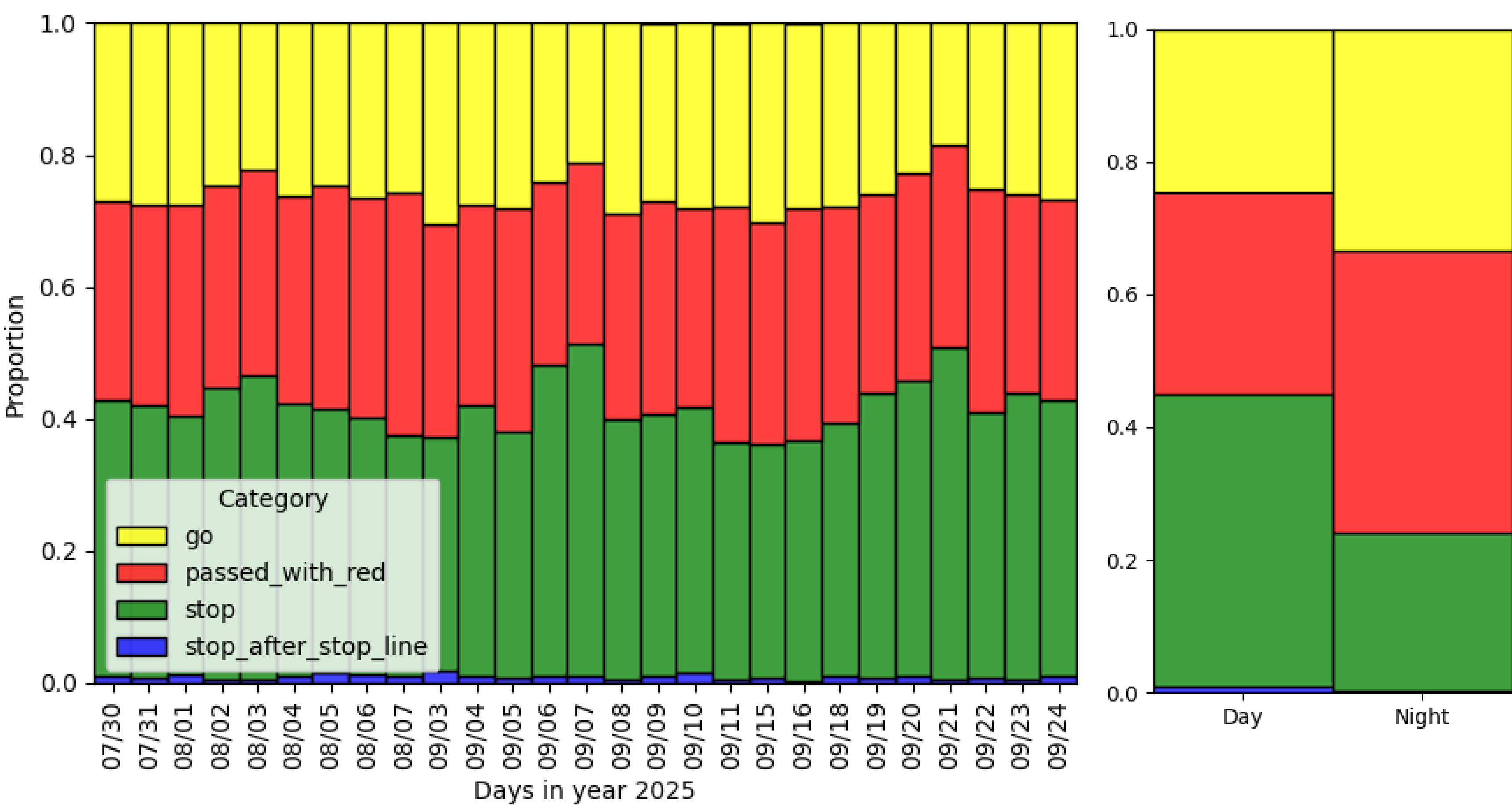


Figure 2: Proportional distribution of behaviour in the dilemma zone over time (left) and overall day vs. night (right).

	Distance (m)				Speed (m/s)				Acceleration (m/s²)			
Behaviour	1	2	3	4	1	2	3	4	1	2	3	4
Day	26	36	44	37	9	10	11	9	0.5	0.4	0.3	0.4
Night	32	41	46	38	11	12	12	13	0.4	0.4	0.4	0.0
Difference	6	5	2	1	2	2	1	4	-0.1	0.0	0.1	-0.4

Table 1: Mean values of key variables related to driver behavior according to [2].

References

[1] Gazis, D.C.; Herman, R.; Maradudin, A. The Problem of the Amber Signal Light in Traffic Flow. *Oper. Res.* 1960, 8, 112–132.

[2] Papaioannou, P., Papadopoulos, E., Nikolaidou, A., Politis, I., Basbas, S., & Kountouri, E. (2021). Dilemma Zone: Modeling Drivers’ Decision at Signalized Intersections against Aggressiveness and Other Factors Using UAV Technology. *Safety*, 7(1), 11. <https://doi.org/10.3390/safety7010011>

[3] Knake-Langhorst, S., & Gimm, K. (2016). AIM Research Intersection: Instrument for traffic detection and behavior assessment for a complex urban intersection. *Journal of large-scale research facilities*.

[4] One day of data is publicly available: Schicktanzt, C., Klitzke, L., Gimm, K., Knake-Langhorst, S., Rizzo, G., Mosebach, H. H., Liesner, K., & Scholz, M. (2025). DLR Urban Traffic dataset (DLR UT) v1.3.0. Zenodo. <https://doi.org/10.5281/zenodo.15754836>

Abstract

- Analyzed 27 days of trajectory data from a signalized high-traffic urban intersection [3]
- Out of 614,615 recorded traffic participants, 32,260 were in the dilemma zone. Their behavior was classified into four groups (Fig. 2).
- At night, the probability of running a red light is 13% higher, and running a yellow light is 8% higher compared to daytime. Thus, drivers are 21% more likely not to stop at night.

Definition Dilemma Zone

- Concept introduced in the 1960s [1]
- Refers to the area at a signalized intersection where, at the onset of yellow, drivers cannot safely stop before the stop line or clear the intersection (see Fig. 1) [1]

Method

1. Record videos and extract trajectory data
2. Identify the traffic signal relevant for each object
3. Extract the corresponding stop line crossed by the object from the digital map
4. Compute distance to stop line (DTS) and time to stop line (TTS)
5. Identify objects in the dilemma zone if $2.5\text{ s} < \text{TTS} < 5.5\text{ s}$ at the onset of yellow
6. Classify behaviour of objects in DZ:
 1. Go (with yellow)
 2. Passed with red
 3. Stop
 4. Stop after stop line
7. Compute behaviour shares over time (Fig. 2)
8. Compare relative day (6 AM–10 PM) vs. night (10 PM–6 AM) distributions of behaviour (Fig. 2)
9. Compute and compare descriptive statistics for driver behaviour at the onset of yellow (Table 1)

Results

- Extracted 614,615 trajectories from video recordings (July–September 2025) [4]
- 32,260 objects identified in the DZ (5%)
 - 31,916 during daytime
 - 344 during nighttime
- Behavioral change from day → night (see Fig. 2):
 - Go with yellow: 26 % → 34 %
 - Passed with red: 32 % → 45 %
 - Stop: 41 % → 21 %
 - Stop after stop line: 1 % → 0 %

