

# Automated video analysis and behavioural studies based on individual speed profiles

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# Speed in traffic safety research

**Power model [Nilsson, 2004]:**

$$\frac{\text{Number\_injury\_accidents}_{after}}{\text{Number\_injury\_accidents}_{before}} = \left( \frac{v_{after}}{v_{before}} \right)^2$$

$$\frac{\text{Number\_fatal\_accidents}_{after}}{\text{Number\_fatal\_accidents}_{before}} = \left( \frac{v_{after}}{v_{before}} \right)^4$$



# Speed in traffic safety research

[*Lee, Hellinga & Saccomanno, 2003*]:

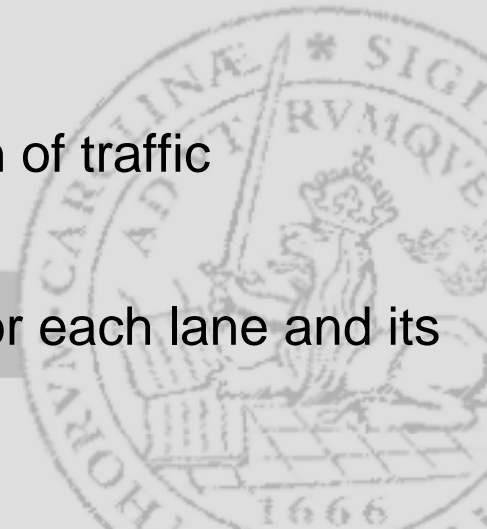
A model for real time identification of potential crash conditions. Crash precursors:

- Variation of speed on each lane;
- Variation of speed between the lanes;
- Traffic density.

[*Golob & Recker, 2004*]:

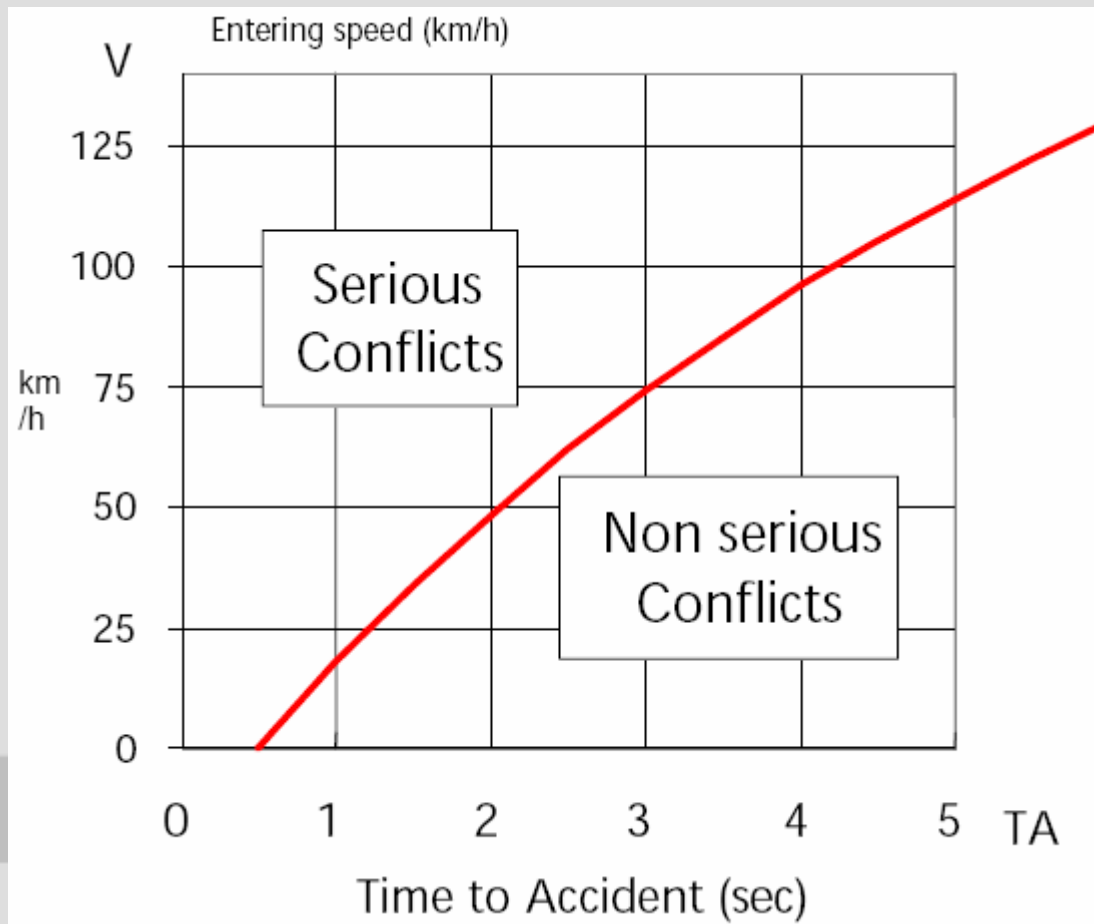
Crash type and location are related to certain combination of traffic parameters:

- flow & flow variation for each lane;
- flow/occupancy ratio (i.e. surrogate for speed) for each lane and its variation.



# Speed in traffic safety research

Swedish Traffic Conflict Technique [Hydén, 1987]



# Speed in traffic safety research

[*Malkhamah et.al., 2005*]:

**Deceleration** (i.e. 1st derivative of speed) is a valid indicator for a conflict.

- > 3.0 m/s<sup>2</sup> - potential conflicts;
- > 4.5 m/s<sup>2</sup> - slight conflicts;
- > 6.0 m/s<sup>2</sup> - serious conflicts.



# Speed in traffic safety research

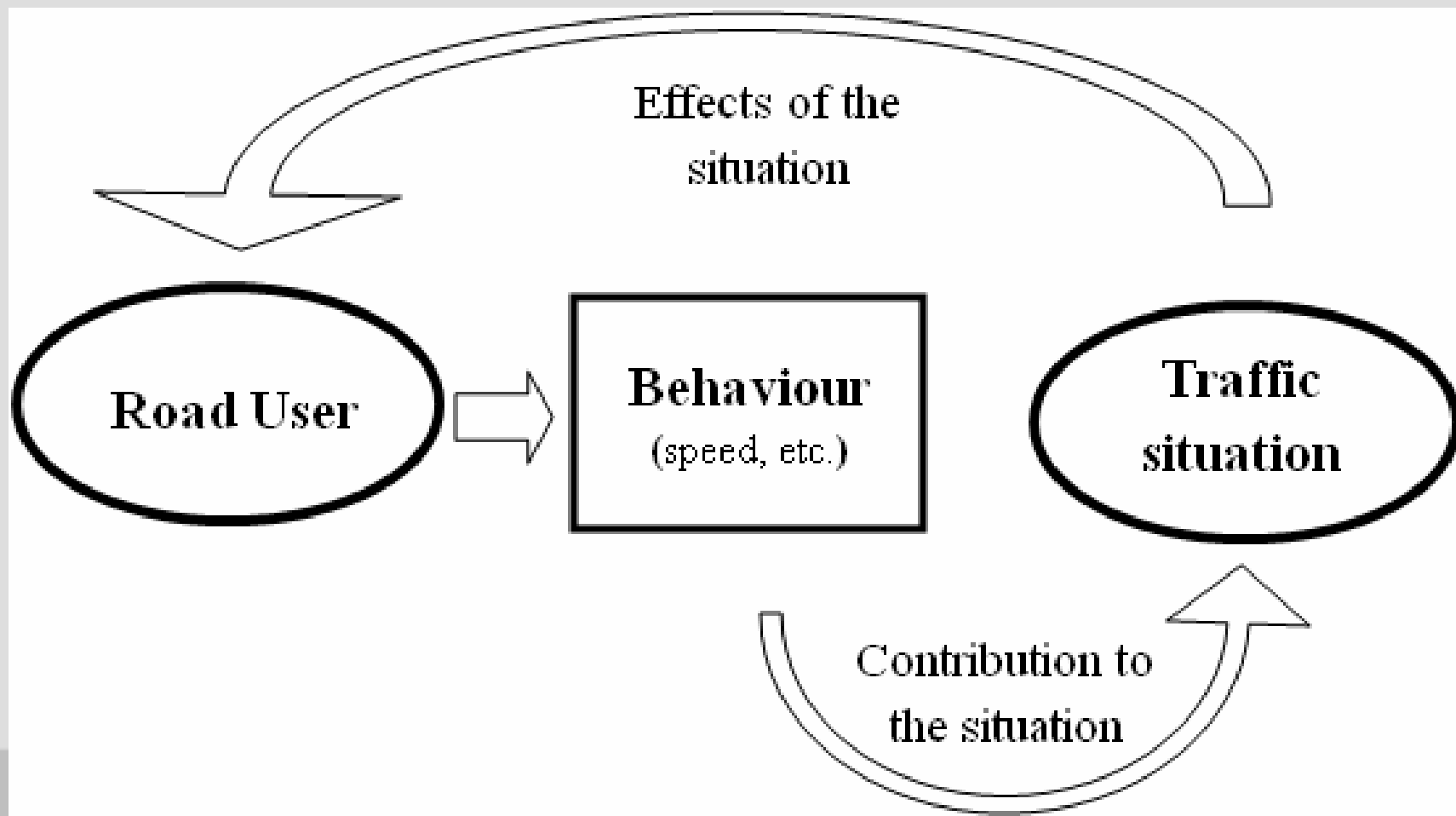
[Nygård, 1999]:

The derivative of deceleration, “**jerk**” (i.e. 2<sup>nd</sup> derivative of speed) is a much better indicator for serious conflicts compared to deceleration.

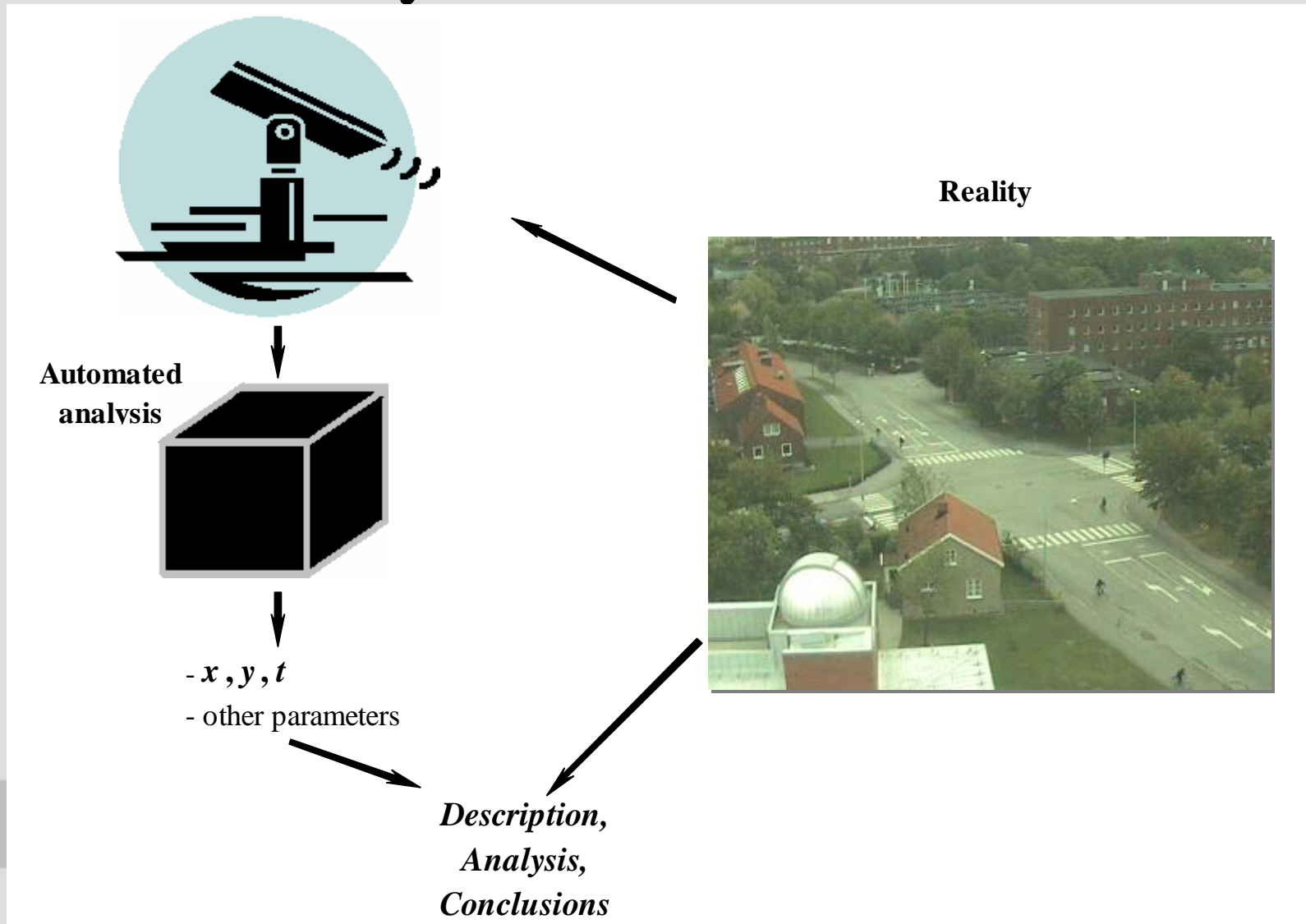
“Jerk” describes the “suddenness” of the braking.



# Speed in traffic safety research

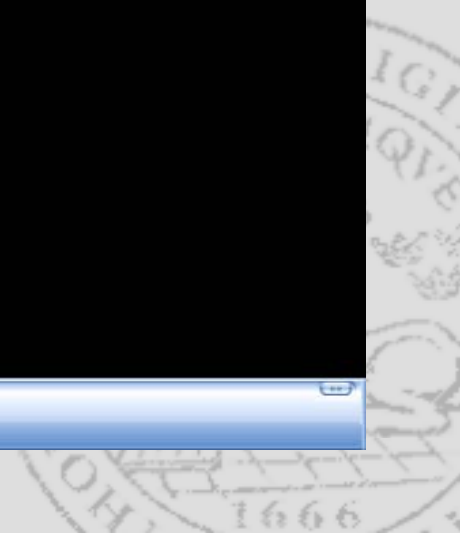
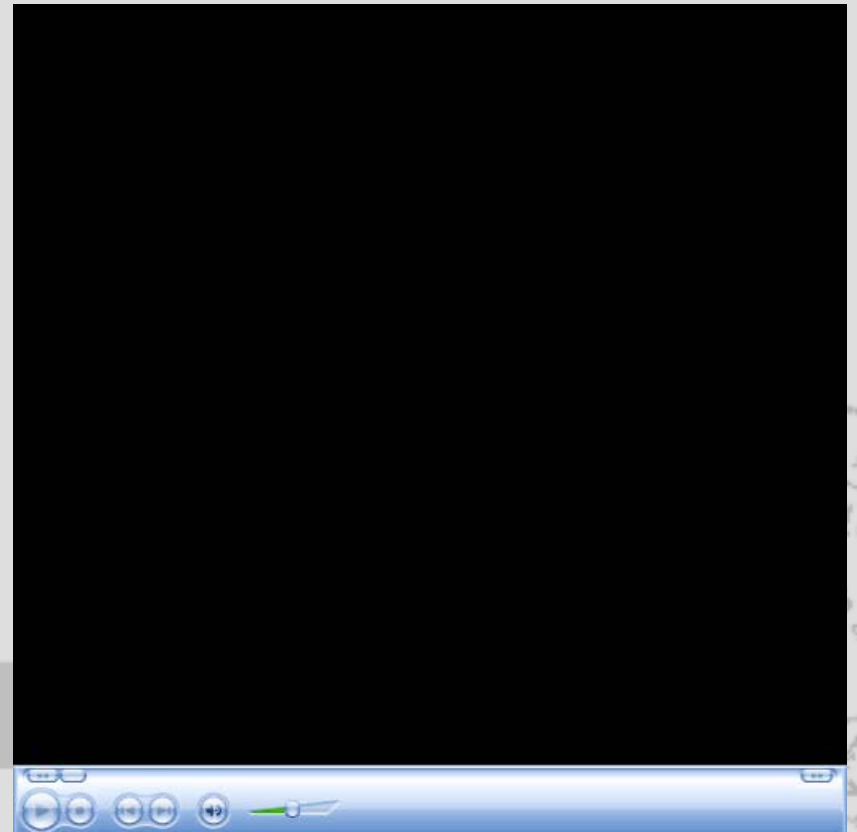
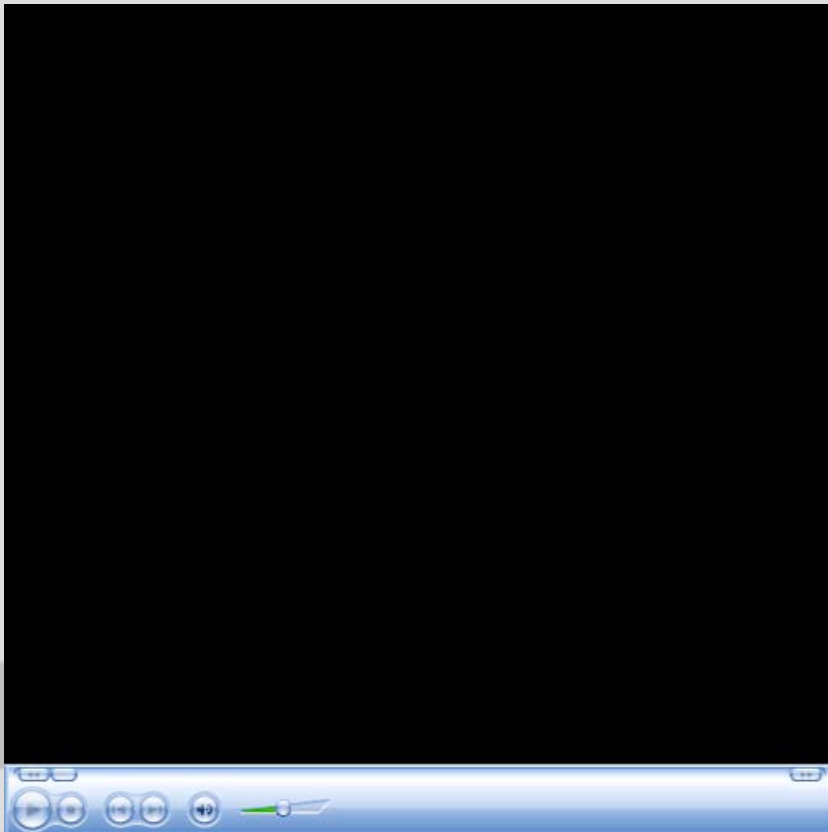


# Video analysis as a researcher's tool



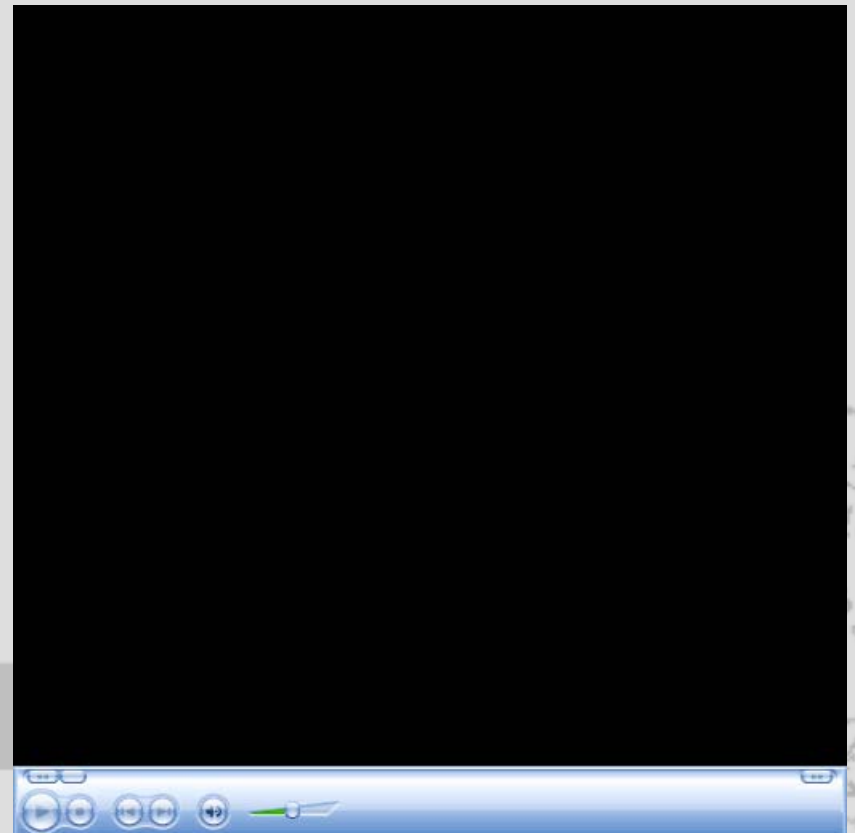
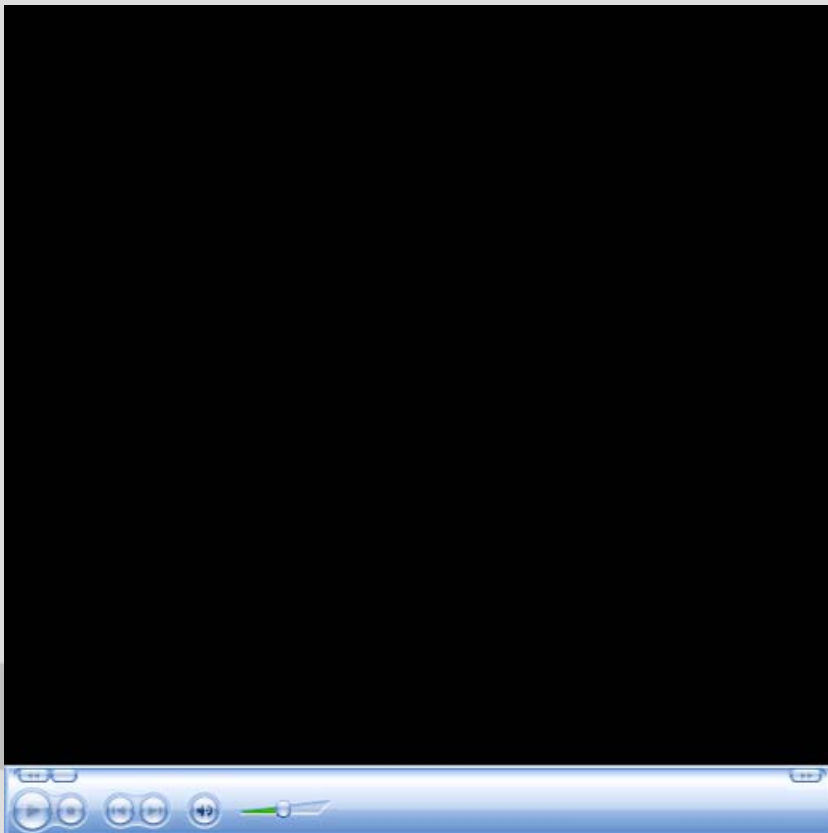
# How do we analyse video?

Step I – rectify the image



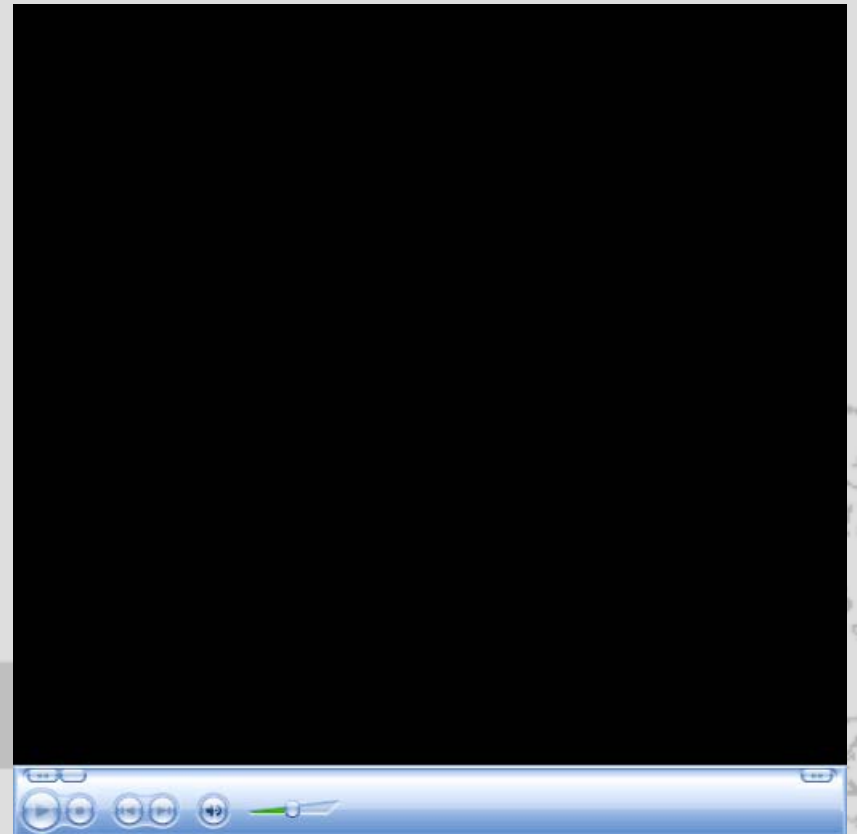
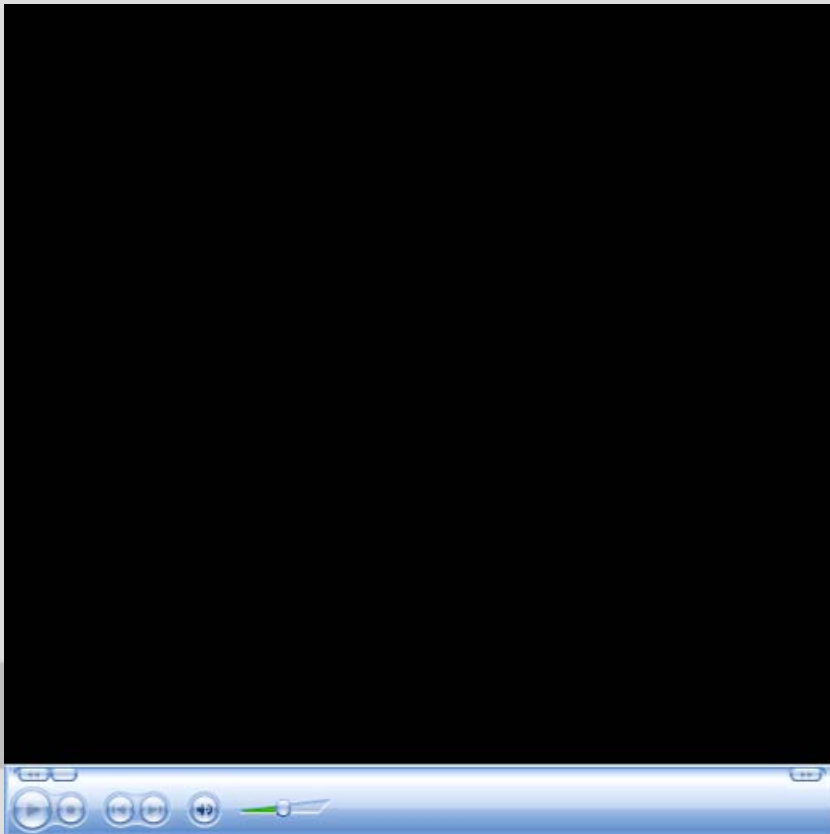
# How do we analyse video?

Step II – detect the changed pixels



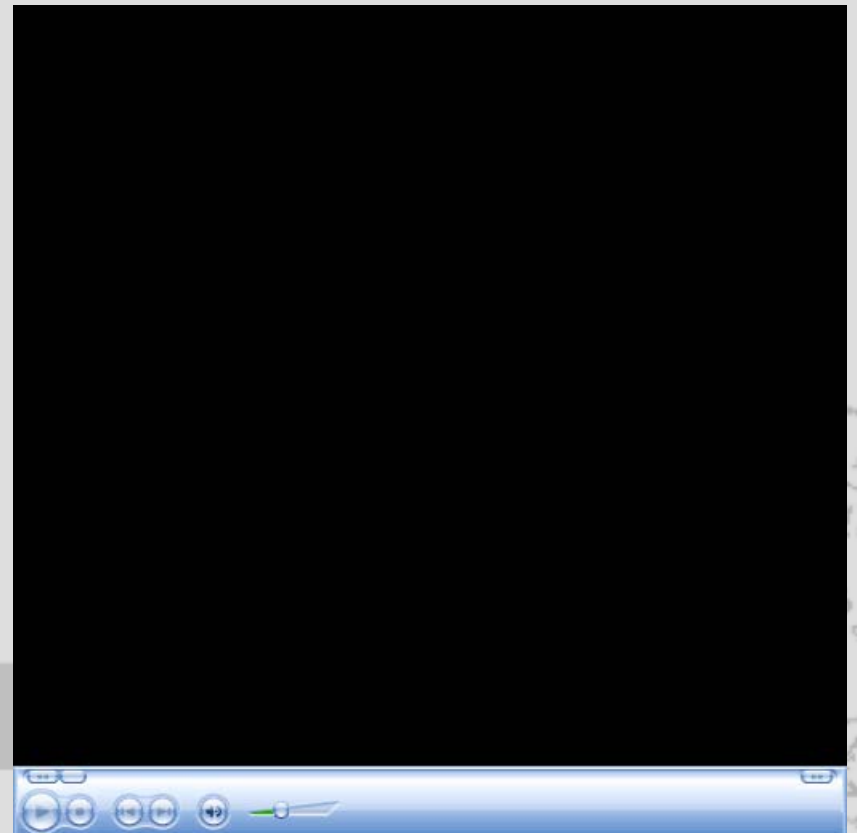
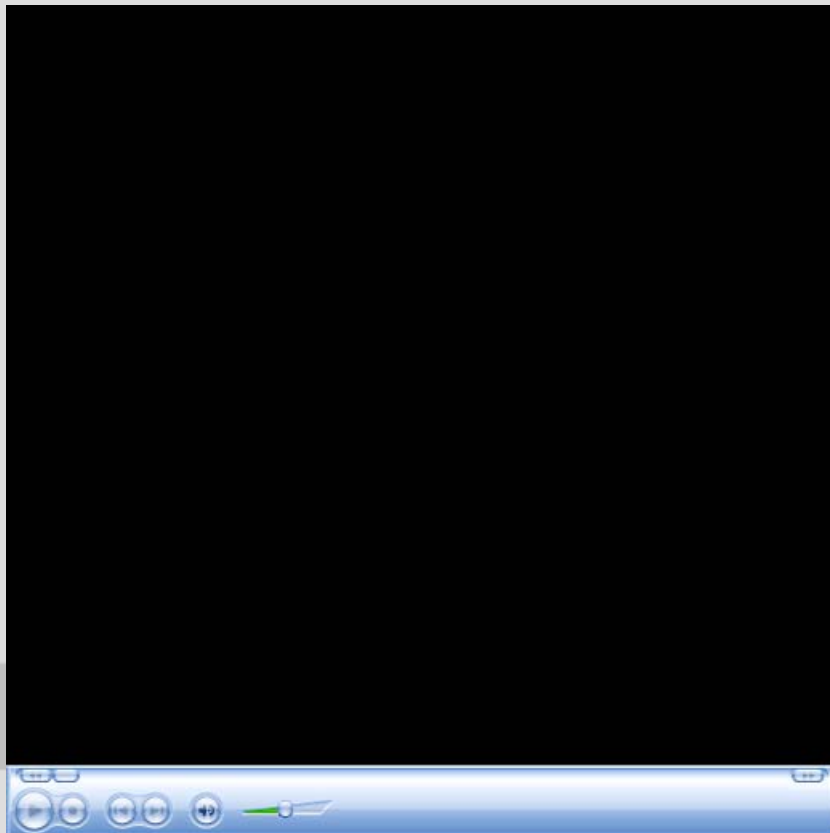
# How do we analyse video?

**Step III** – filter the pixels, forming large areas



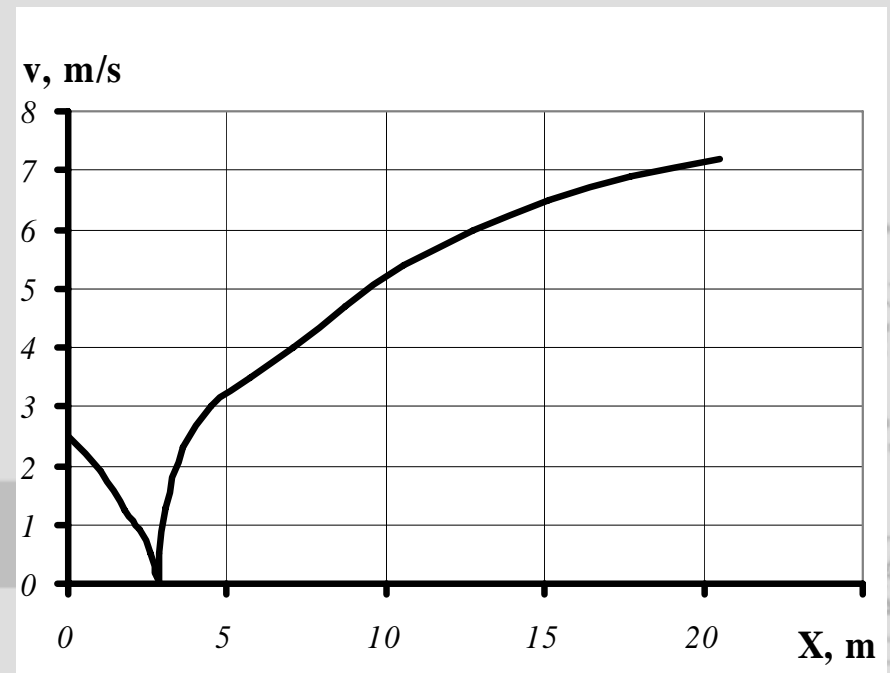
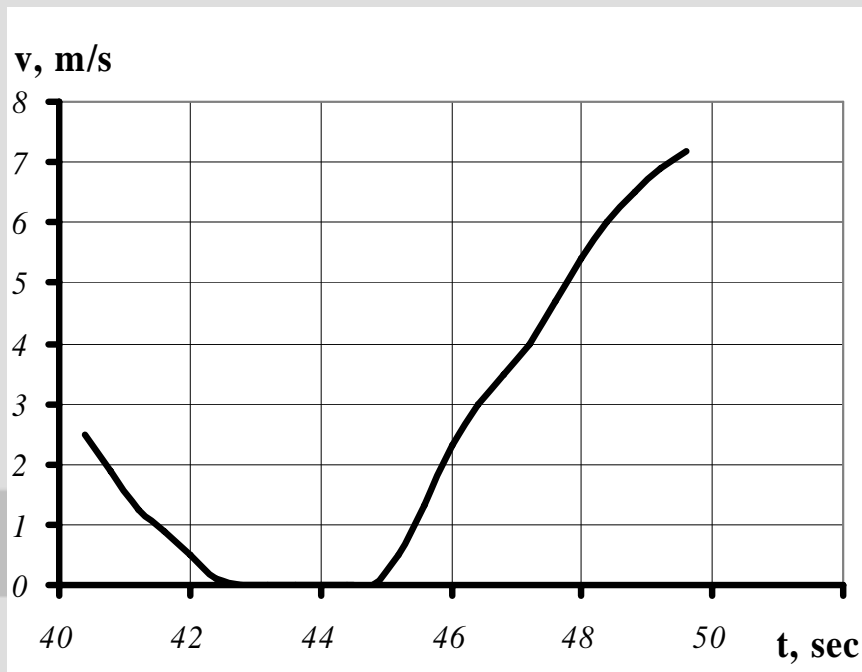
# How do we analyse video?

Step IV – follow each area's travelling path



# How to deal with speed profile data?

**Speed profile** - the dataset, describing road users' speed over a certain continuous period of time.



# How to deal with speed profile data?

Data aggregation is necessary.

## Example:

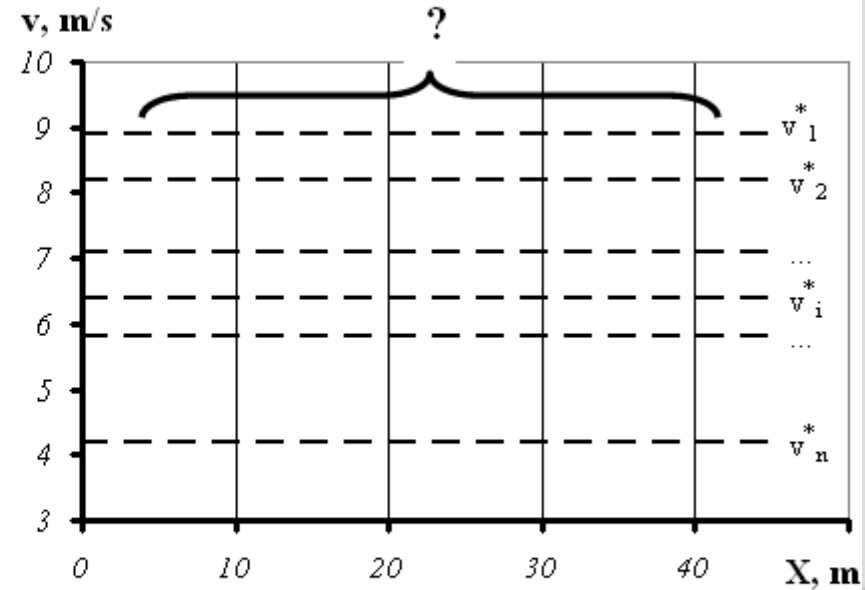
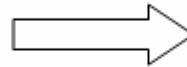
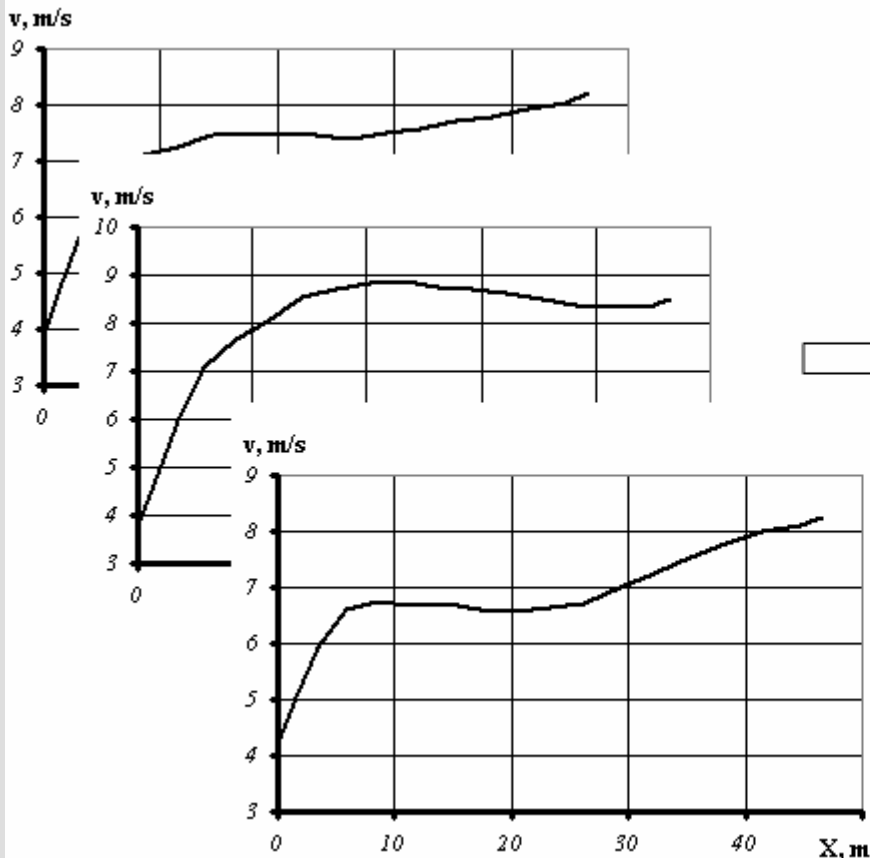
- 25 frames/second;
- 40 km/h;
- 150 m.
- 1200 veh/h.

$\Rightarrow 150 * (40 / 3,6) * 150 = 338$  data points per vehicle.

$\Rightarrow 338 * 1200 = 405\ 600$  points per hour of observations.



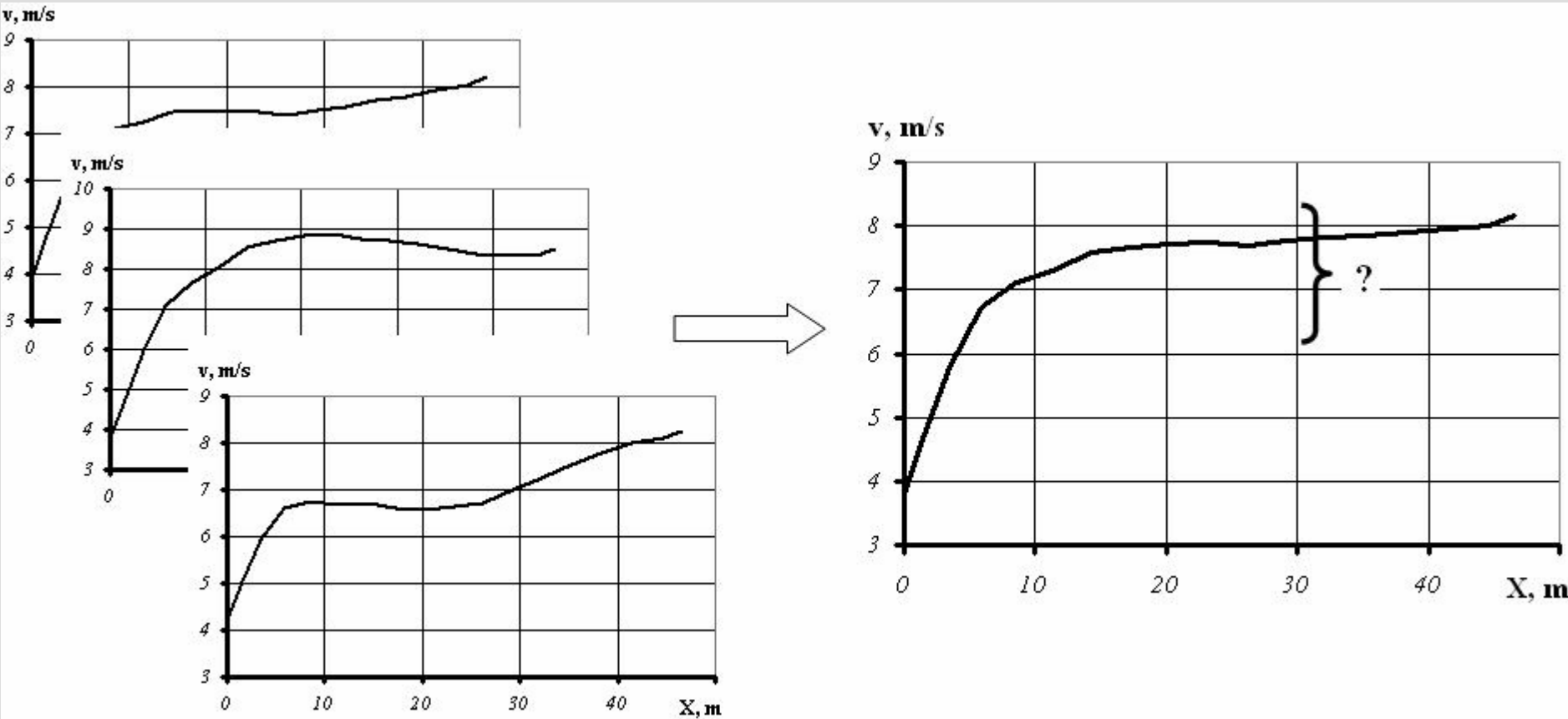
# How to deal with speed profile data?



Individuality is preserved, but spatial dimension is lost.



# How to deal with speed profile data?



Spatial dimension is preserved, but individuality is lost.



# Practical test

## Sölvegatan-Tornavägen, Lund

102 veh/h

heavy 12%

turning 37%

264 veh/h

heavy 11%

turning 12%



252 veh/h

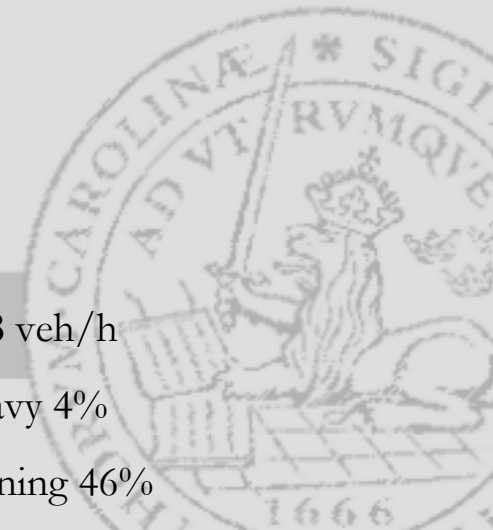
heavy 7%

turning 10%

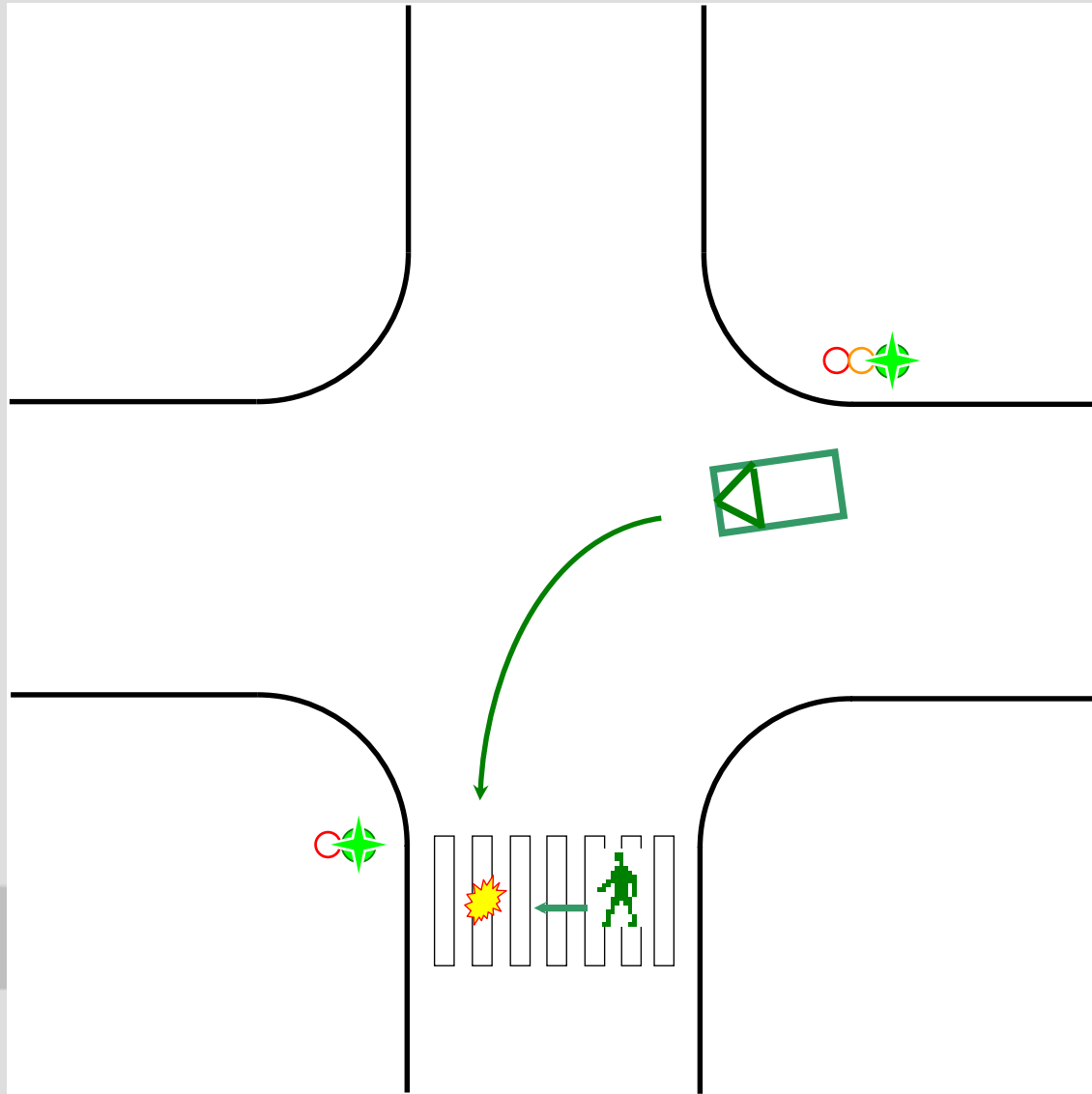
138 veh/h

heavy 4%

turning 46%

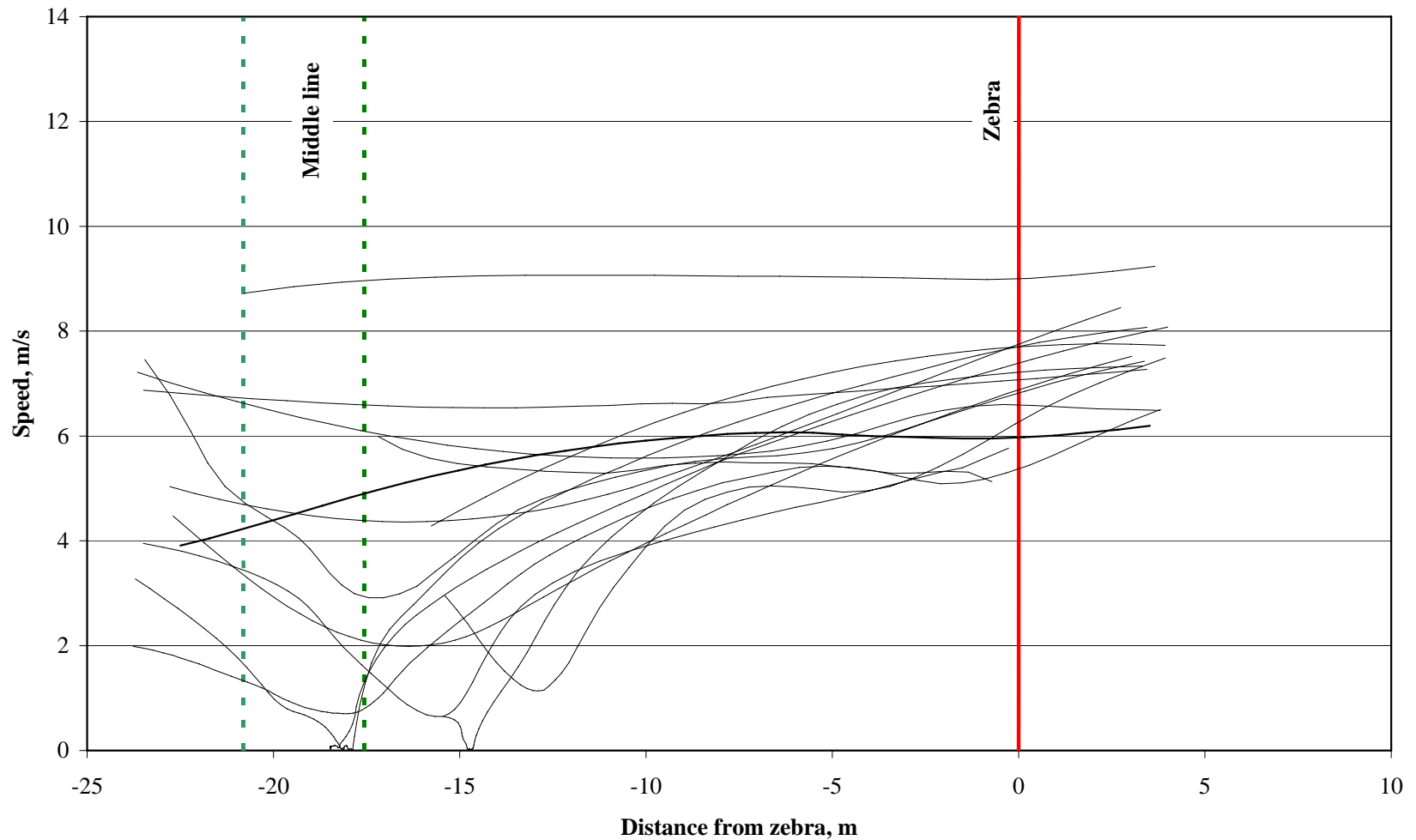


# Practical test



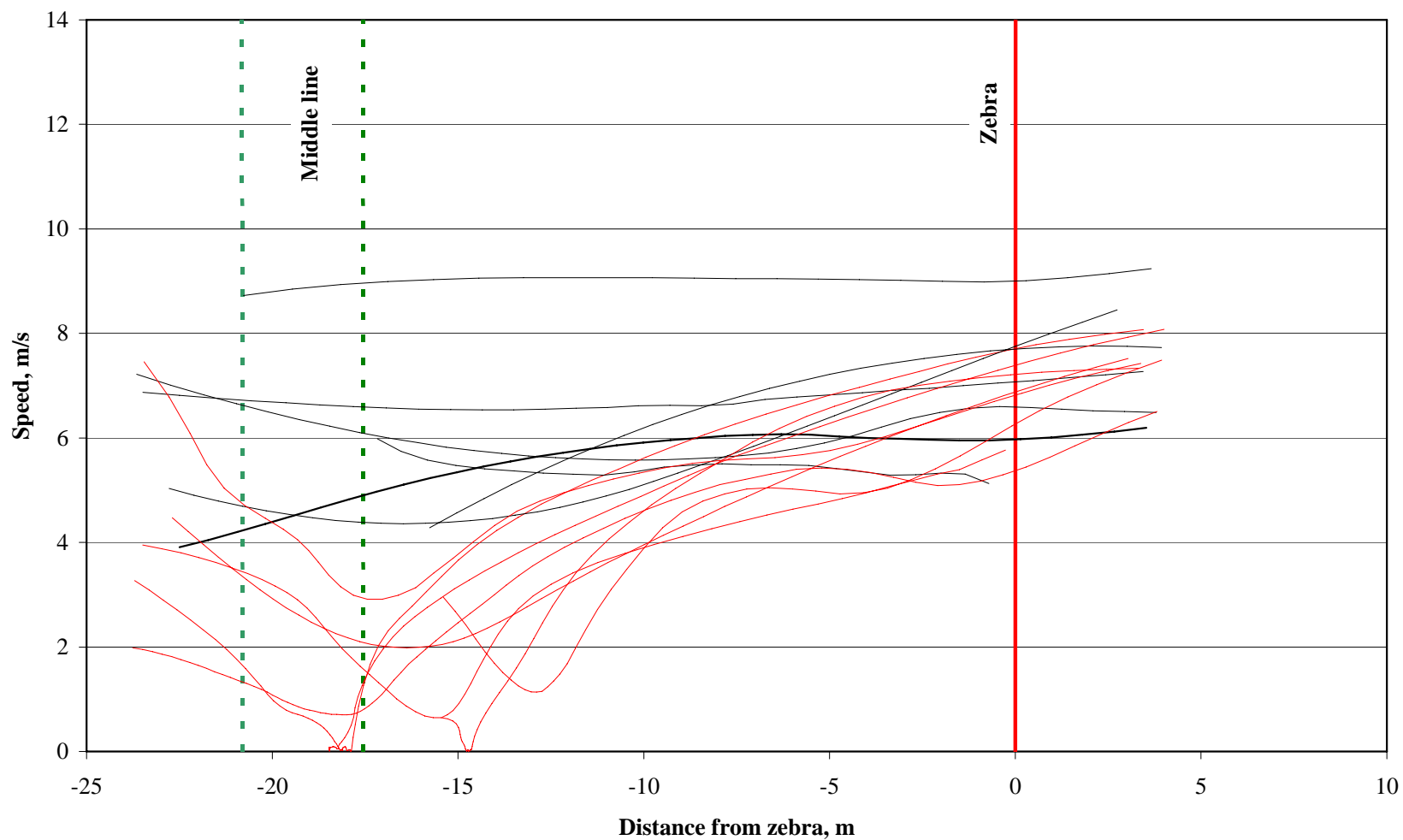
# Practical test

No pedestrian (15 profiles)



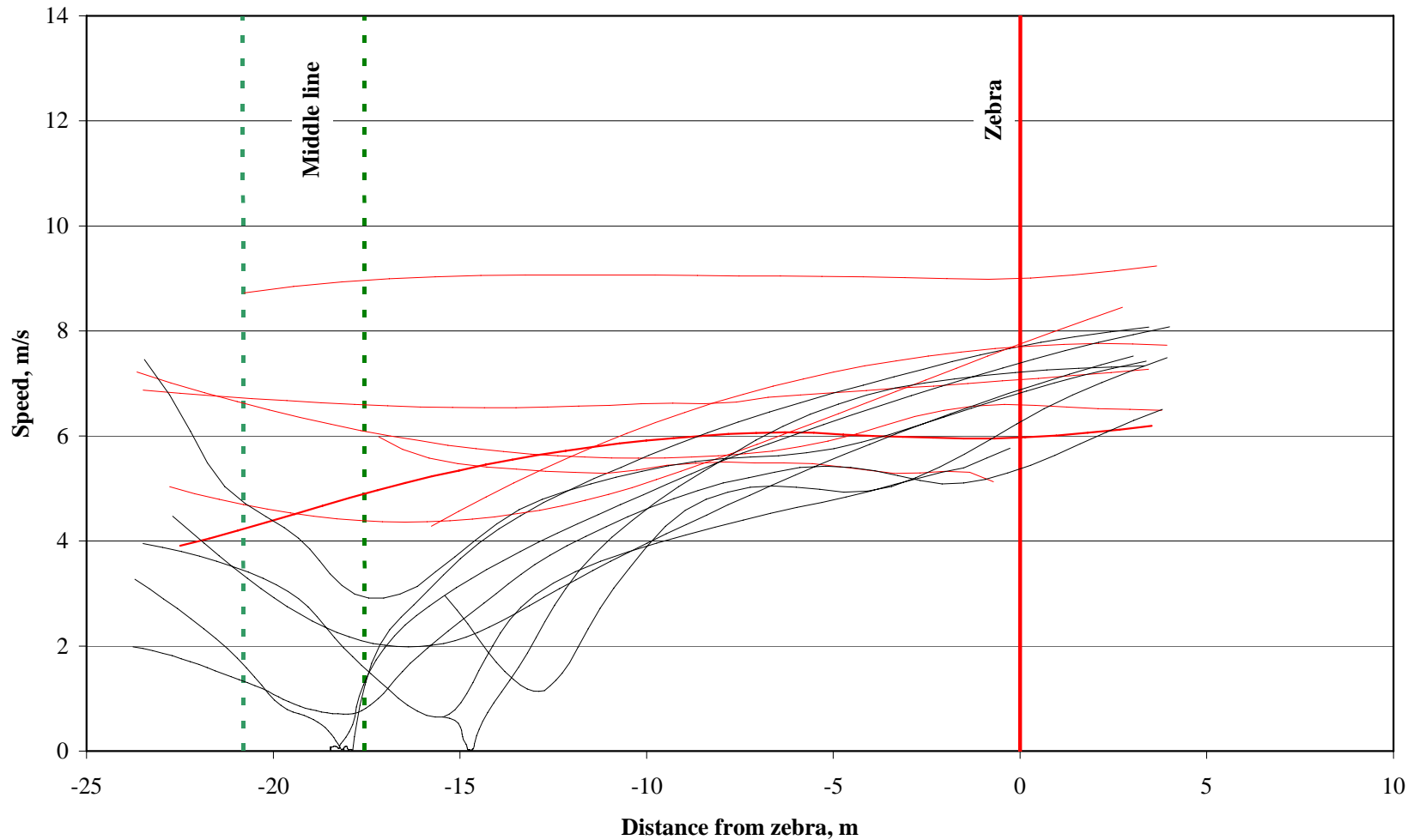
# Practical test

No pedestrian



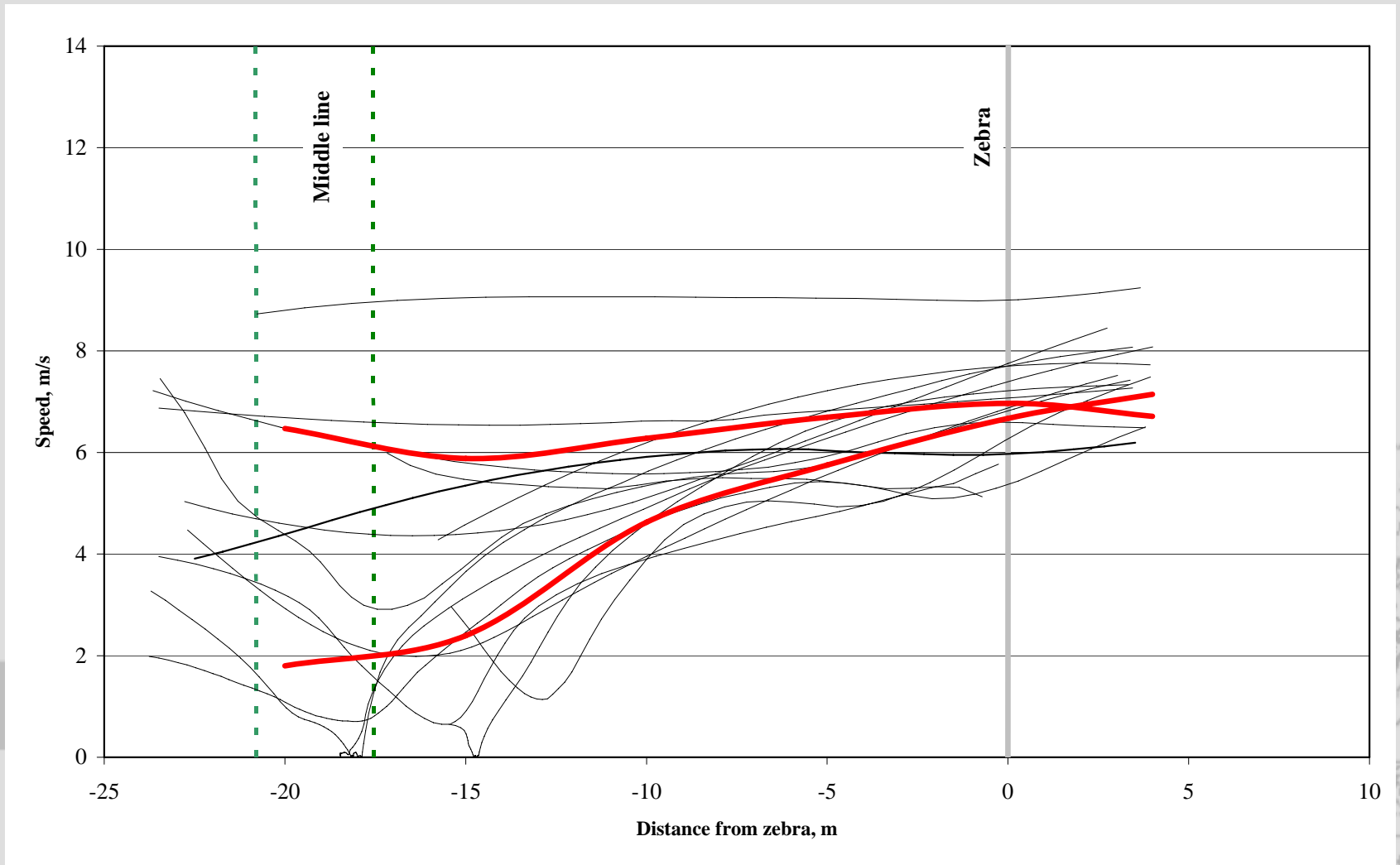
# Practical test

No pedestrian



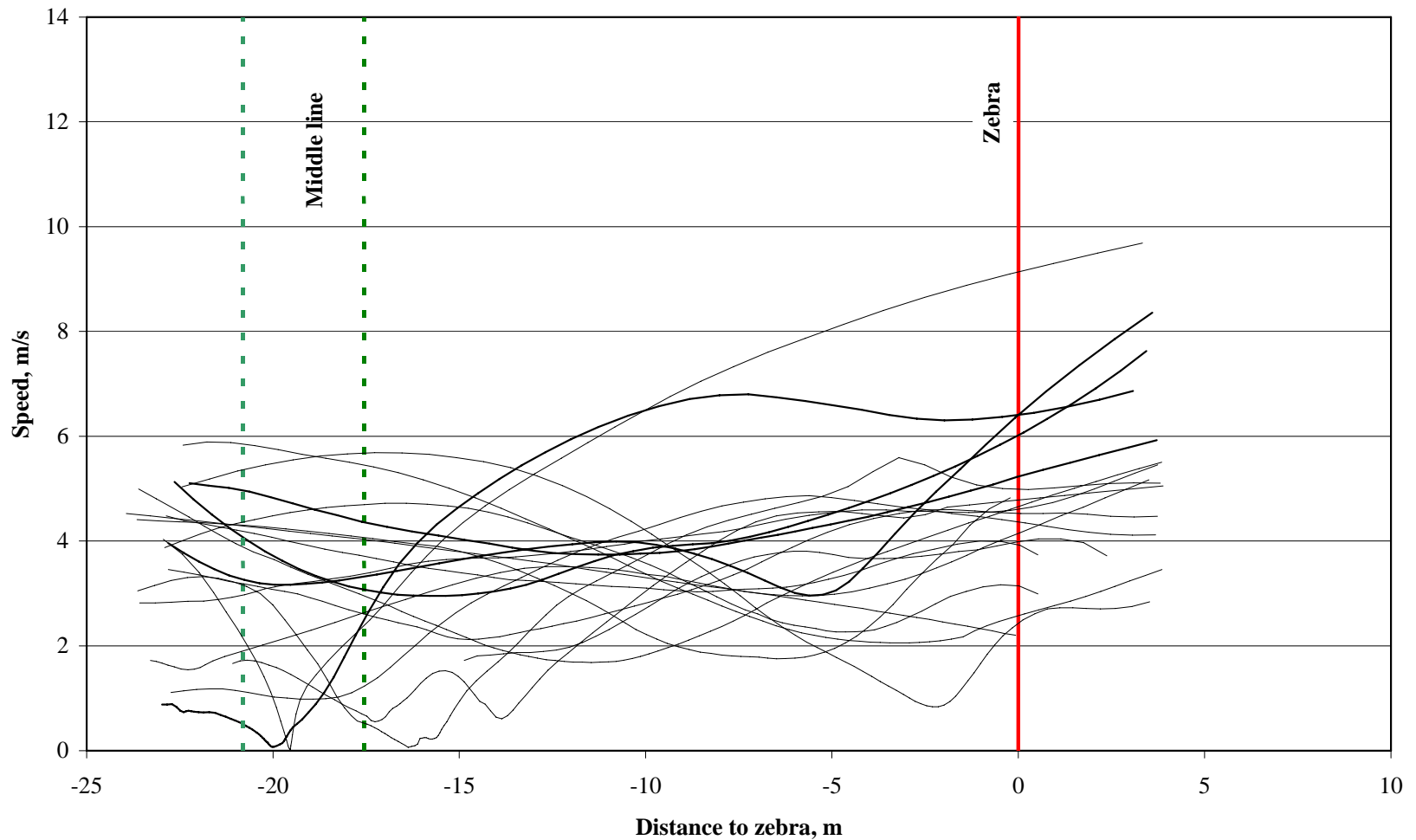
# Practical test

No pedestrian



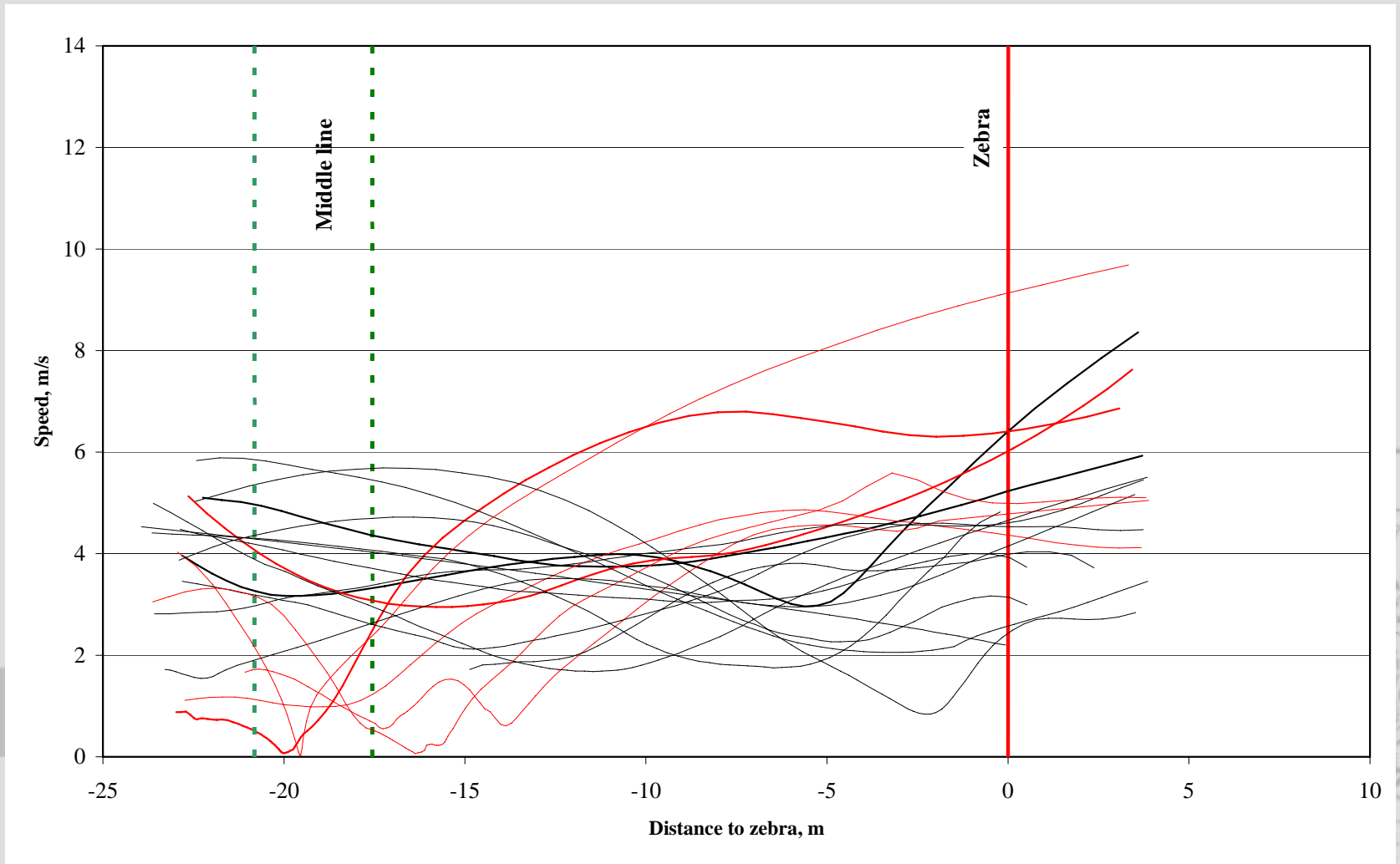
# Practical test

Pedestrian present (19 profiles):



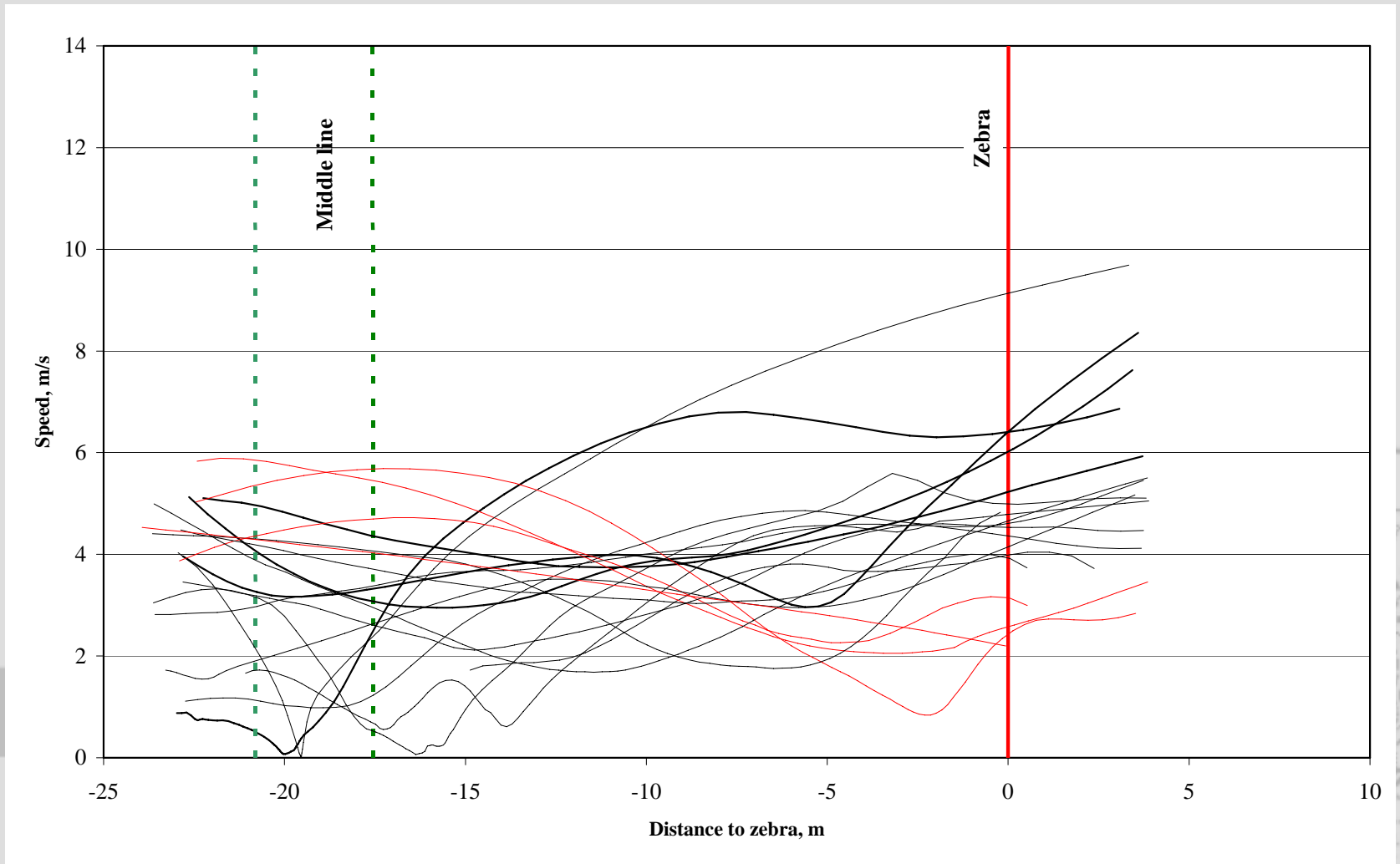
# Practical test

Pedestrian present



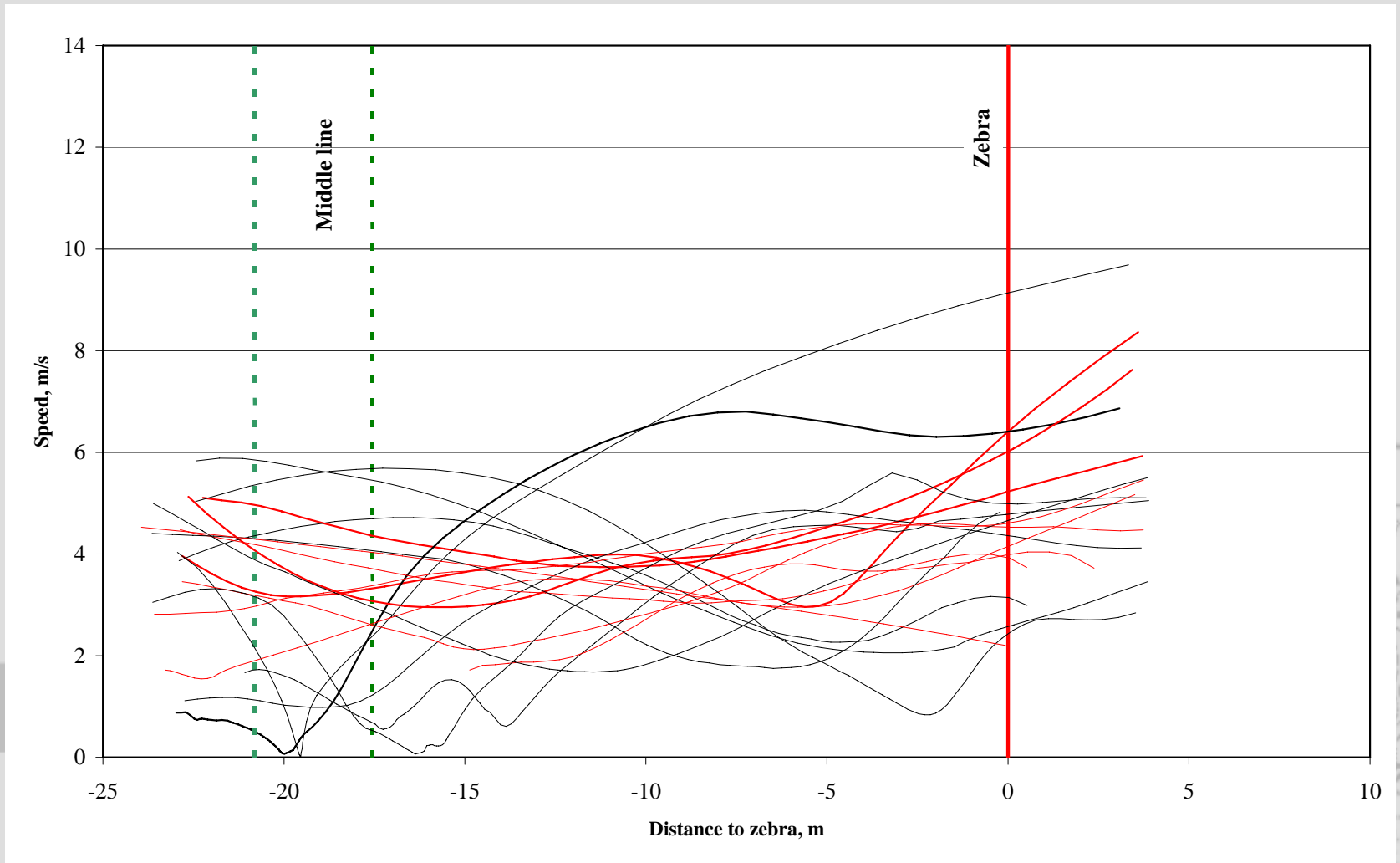
# Practical test

Pedestrian present



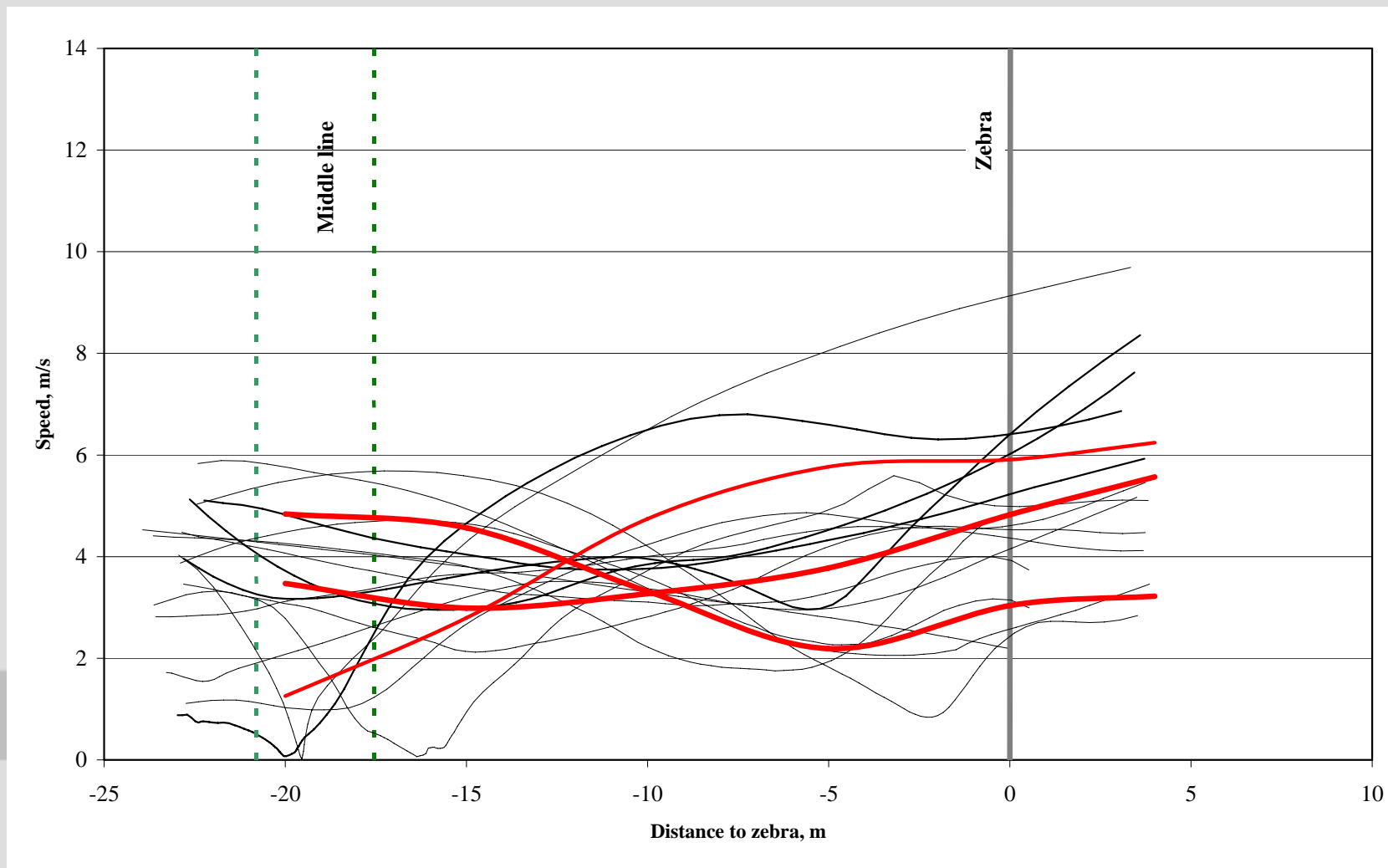
# Practical test

Pedestrian present



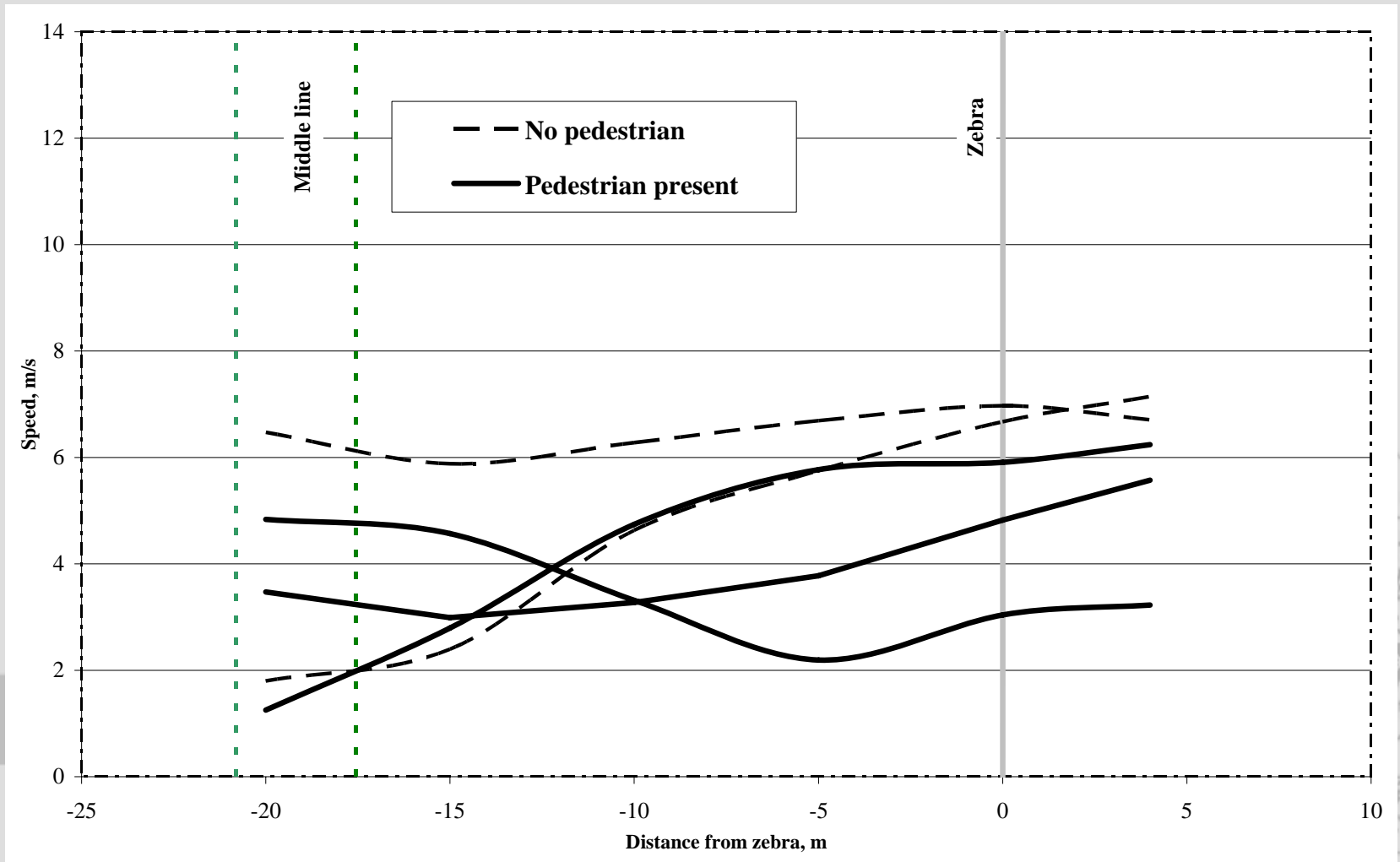
# Practical test

Pedestrian present



# Practical test

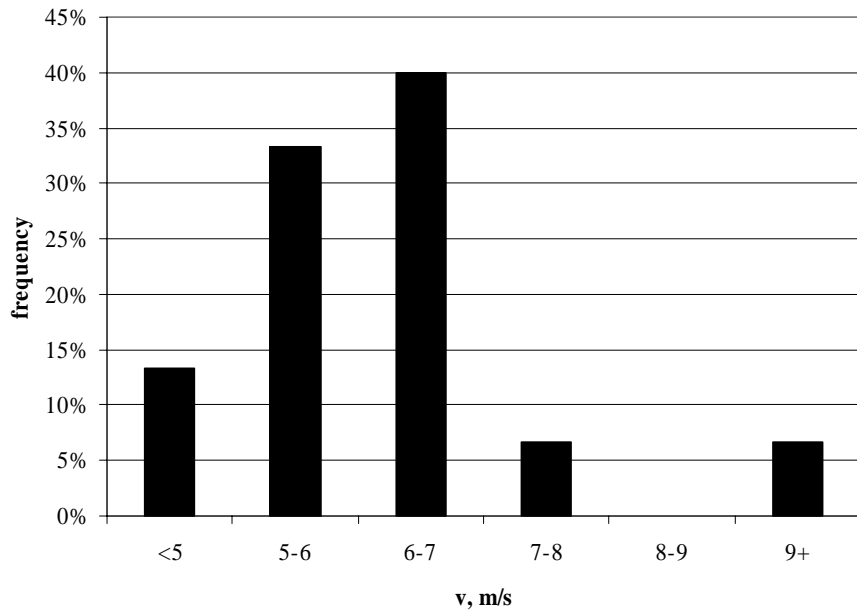
How a pedestrian affects the drivers?



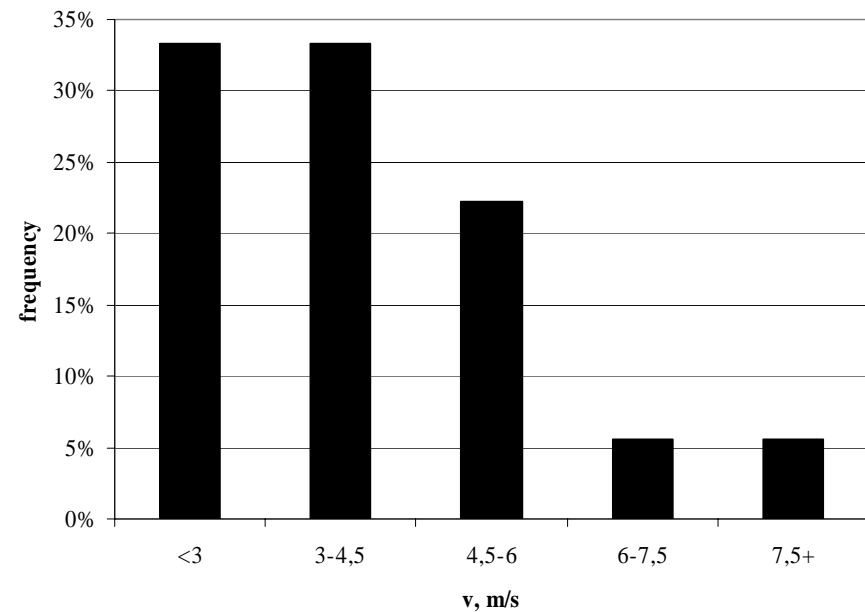
# Practical test

Speed distribution 5 m before the zebra

No pedestrian



Pedestrian present

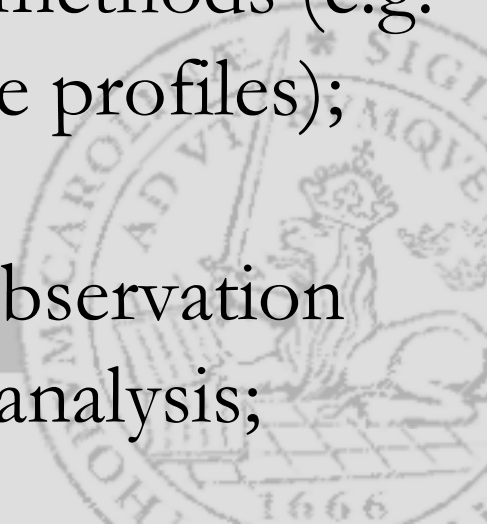


# Discussion

The test shows that it is practically possible to perform all the steps in a typical study of road users' behaviour;

Speed profiles from automated video analysis system provide additional information which cannot (or is quite difficult) to obtain by conventional methods (e.g. a visually distinguished “characters” of the profiles);

The system allows to have much longer observation periods, thus collect much more data for analysis;



# Discussion

On the other hand, intensive data flow from the system requires development of special routines for data management and analysis;

Automation of data filtering procedures opens new possibilities for studying of rare events in traffic process, e.g. conflicts.

