Homework: Intelligent Car Following

17.1, 17.3, 17.4

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17.1

Figure 1 gives a speed-distance relationship used by Wiedemann in his psychophysical model to determine the desired minimum following distance at a given speed. This question is based on this figure.

a

The assumed nominal vehicle length (i.e. the spacing when traffic is jammed) is about 8 m, as this is the spacing at zero velocity in the figure.

b

According to the middle curve, the desired minimum following distance at a speed of 30 m/s is just over 20 m.

c

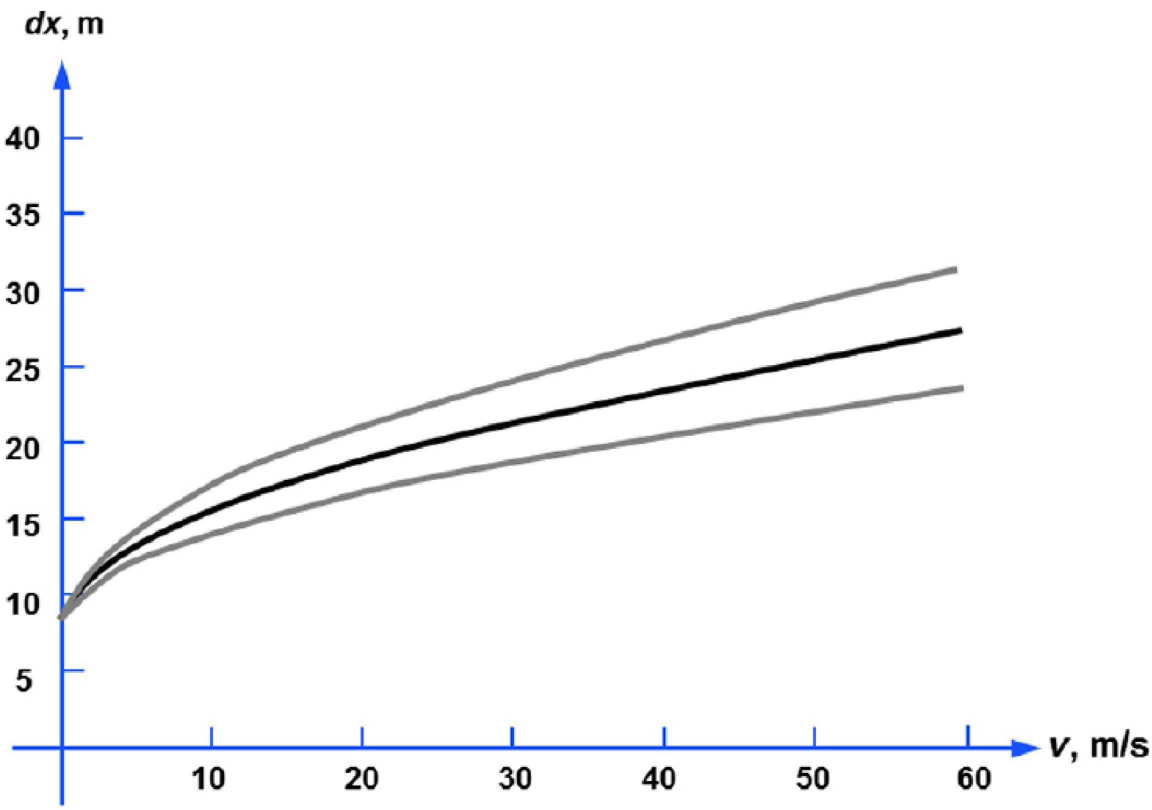

Figure 1: Desired minimum following distance based on speed in Wiedemann's psychophysical model.

17.3

Table 1 gives typical acceleration rates on level road in the CARSIM model.

Table 1: Typical Acceleration Rates on Level Road

Speed Range	Avg. Speed (m/s)	Acceleration (m/s^2)
0–24 kph	3.3	2.68
24–48 kph	10.0	1.68
48–64 kph	15.6	1.58
64–80 kph	20.0	1.27
80–96 kph	24.4	0.94
>96 kph	29.7	0.64

Figure 2 gives an acceleration-speed relationship used in Wiedemann's psychophysical model. The data from Table 1 is also plotted on Figure 2 for comparison.

The accelerations in CARSIM are much less than those in the psychophysical model. Additionally, the accelerations in CARSIM decline much more quickly at low speeds than higher speeds, though the relationship is roughly linear greater than about 15 m/s.

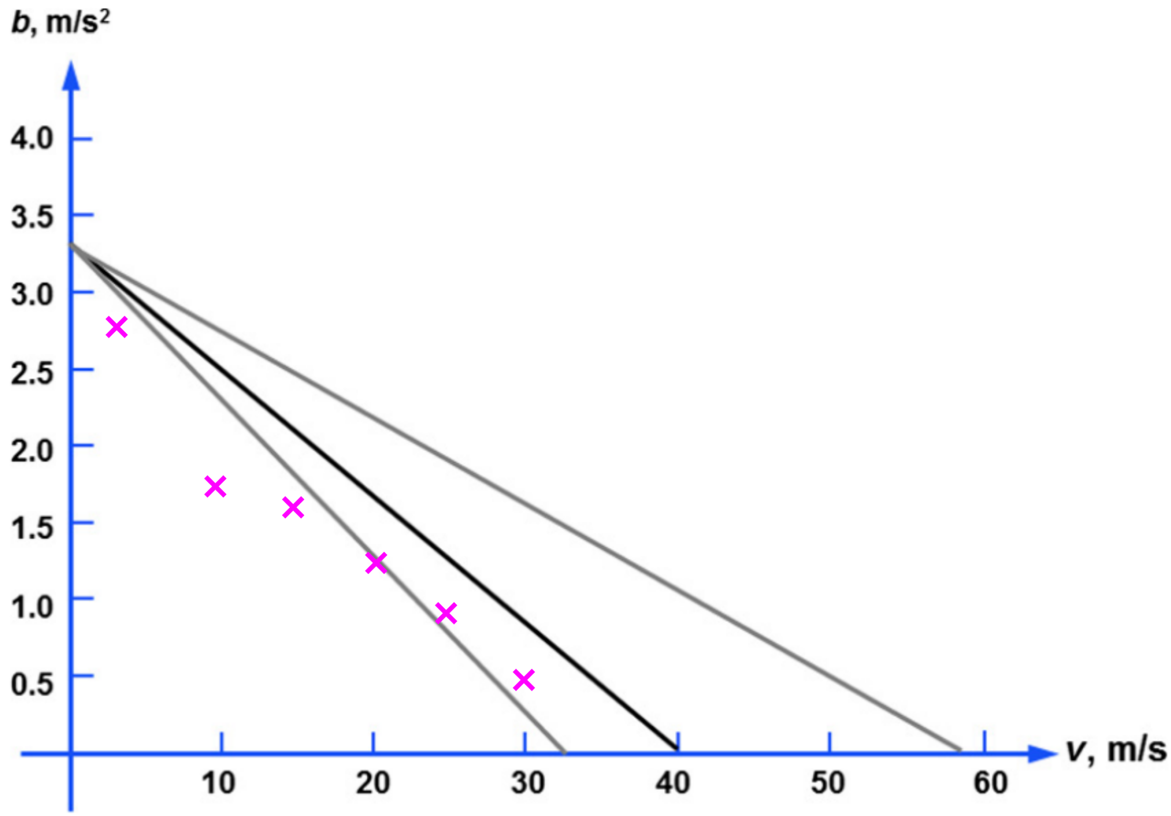

Figure 2: Acceleration-speed relationship in Wiedemann's psychophysical model.

17.4

The rule-based model developed by Kosonen is given below. Several rules exist to determine vehicle behavior, and are as follows (note that later rules supersede earlier ones):

1. No Speed Change
2. Accelerate if $\dot{x}_i < v_i$ and $t - t_{\text{last}} > T_{\text{acc}}(\dot{x})$
3. No Acceleration if $s_{ij} < s_{\min}(\dot{x}_i, \dot{x}_j) + w_{\text{stab}}(\dot{x}_i, \dot{x}_j)$
4. Slow Down if $s_{ij} < s_{\min}(\dot{x}_i, \dot{x}_j)$
5. Do Not Slow Down if $\dot{x}_i < \dot{x}_j$ or $t - t_{\text{last}} < T_{\text{maxdec}}$
6. Goto Zero if $s_{ij} < 0$ (collision)

where $\dot{x}_i$ is the current vehicle speed, $\dot{x}_j$ is the speed of the obstacle, v_i is the desired speed, t_{last} is the elapsed time from the last acceleration, $T_{\text{acc}}(\dot{x})$ is the acceleration rate of the vehicle, s_{ij} is the distance from the obstacle, $s_{\min}(\dot{x}_i, \dot{x}_j)$ is the minimum safe distance, $w_{\text{stab}}(\dot{x}_i, \dot{x}_j)$ is the width of the stable area, and T_{maxdec} is the maximum deceleration rate.

Based on these rules, the following situations would resolve as follows:

A vehicle is entering an empty freeway at 60 kph which has a speed limit of 90 kph. Rules 1 and 2 apply, and so the vehicle accelerates.

A vehicle is traveling on a freeway at the desired speed of 95 kph, with no vehicles in front. Only rule 1 applies, so the vehicle does not change speed.

A 100-kph vehicle is approaching a 90-kph vehicle, with a spacing of 70 m and minimum safe distance 100 m. Rules 1, possibly 2 depending on desired speed, 3, and 4 apply, so the vehicle slows down.

A vehicle with a desired speed of 95 km/h is following its leader, both traveling at a speed 90 km/h with a spacing of 120 m. The minimum safe distance is 100 m, and the stable area is 25 m. Rules 1, 2, and 3 apply, so the vehicle does not accelerate.

A vehicle at a speed of 70 km/h is changing to the target lane, where there is a leader traveling at a speed of 90 km/h. The spacing between the two vehicles is 70 m, and the minimum safe distance is 100 m. Rules 1, possibly 2, 3, 4, and 5 apply, so the vehicle does not slow down.