Beat the Traffic: A Learning Game for STEPCon 2020

Presented by:

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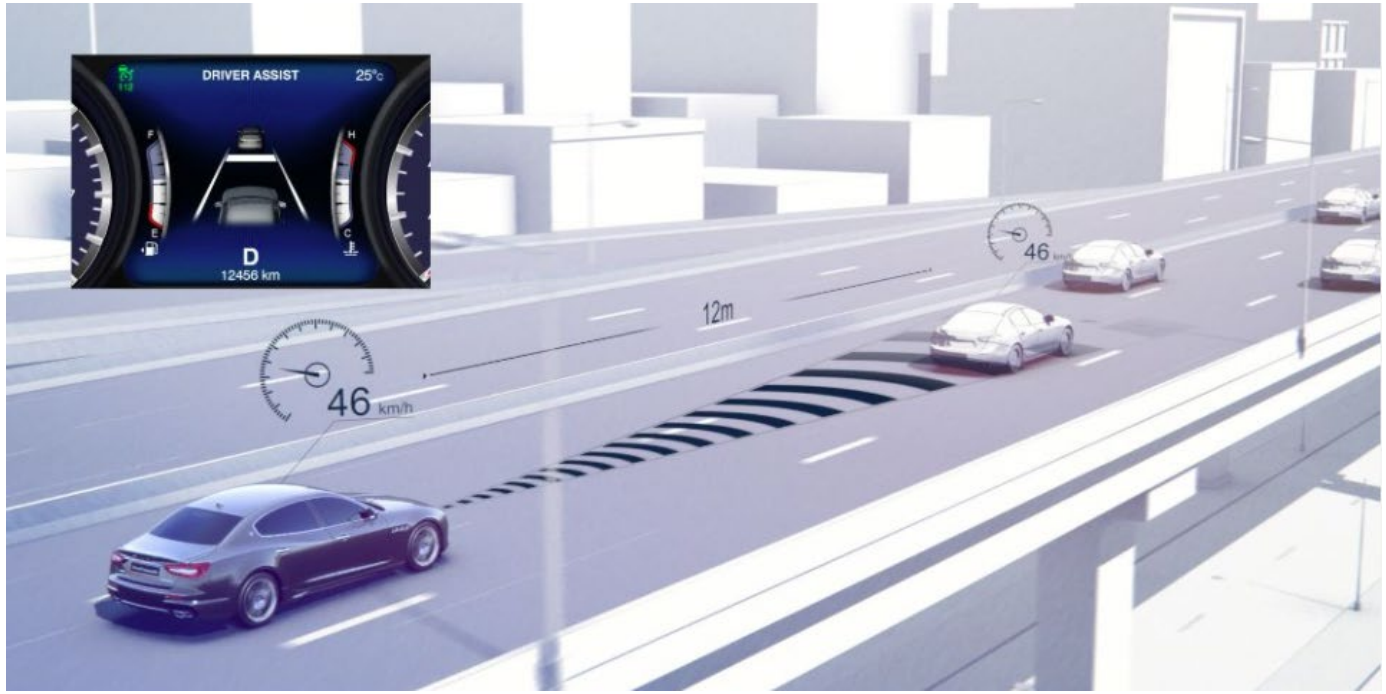
Adaptive Cruise Control

- **Adaptive Cruise Control (ACC) consists of two main parts:**
  - **Speed control**
  - **Gap control**



Retrieved from https://www.maserati.com

Adaptive Cruise Control

- **Speed control equations:**

$$a_{sc} = -0.4(v - v_d), \quad a_{sc} \text{ in } [-2, 2]$$

  - a_{sc} = acceleration required for speed control [m/s^2]
  - v = vehicle speed [m/s]
  - v_d = desired speed [m/s]

- **Gap control equations:**

$$a_{gc} = \dot{s} + 0.25(s - T_d v)$$

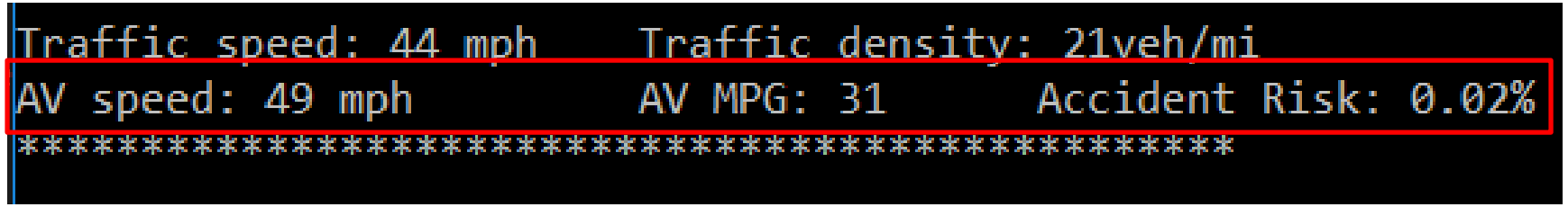
$$a_{gc} \text{ in } [-2, a_{sc}]$$

  - a_{gc} = acceleration required for gap control [m/s^2]
  - s = gap [m] from vehicle ahead
  - $\dot{s}$ = rate of change of gap [m/s]
  - T_d = desired time gap [sec]

The ACC Game

- **You will adjust these parameters to get through traffic in a faster, safer, and/or more fuel-efficient way:**
  - v_d = desired speed [m/s]
  - T_d = desired time gap [sec]

- **You will be scored based on distance traveled (speed), fuel economy, and accident risk (safety).**

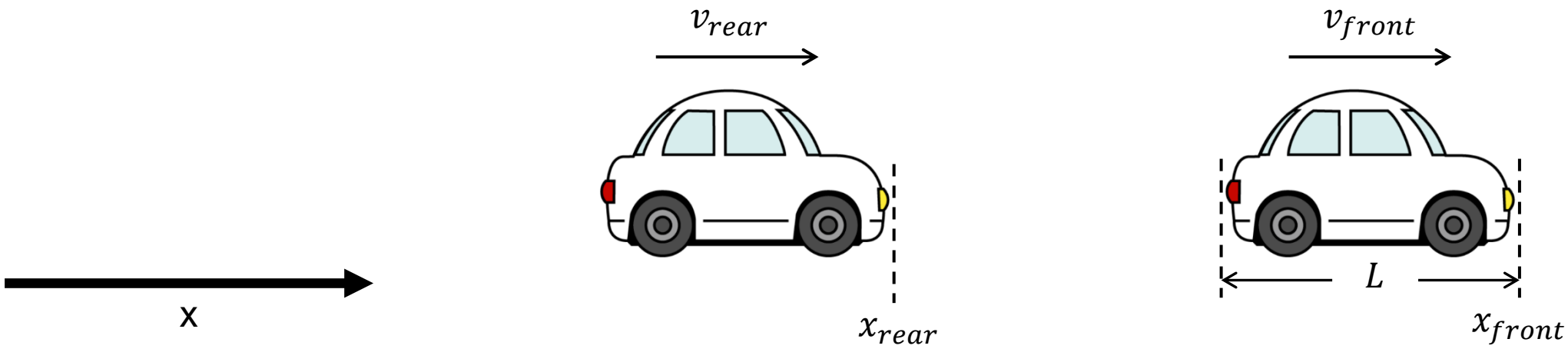


*AV = Automated Vehicle (your vehicle)

Safety: Time-to-Collision

- **Time to Collision (TTC) = the time it would take for two vehicles to collide, if each vehicle continues at its current velocity (speed + direction)**

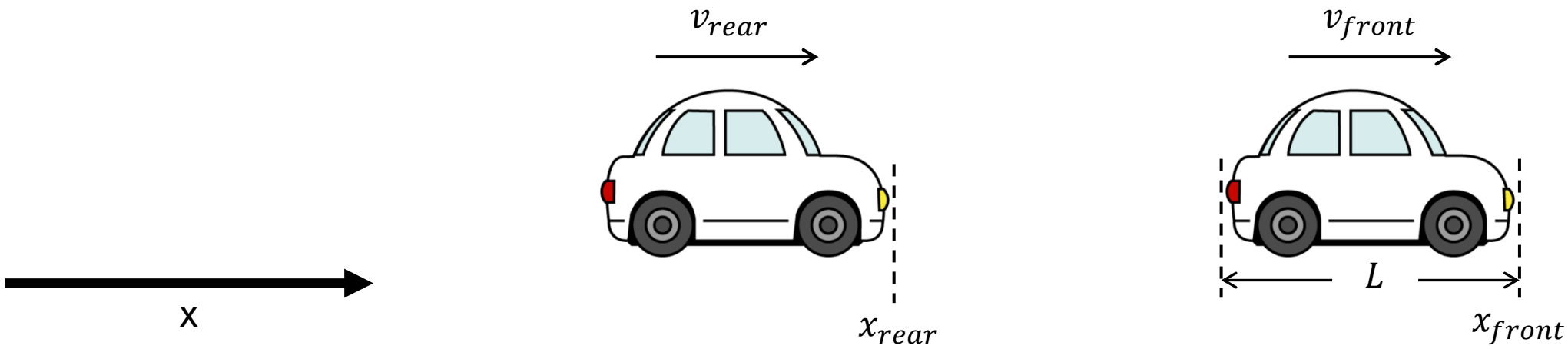
$$\text{TTC} = \frac{x_{front} - x_{rear} - L}{v_{rear} - v_{front}}$$



Safety: Time-to-Collision

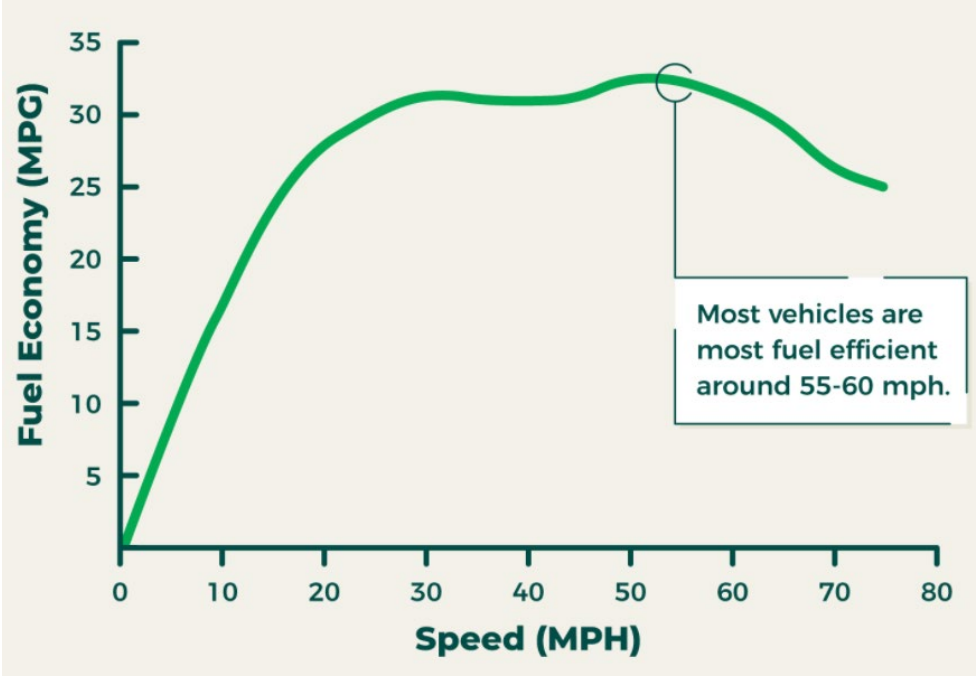
- The larger the gap, the higher the TTC (more safe)
- The larger the speed difference, the lower the TTC (less safe)

$$\text{TTC} = \frac{x_{front} - x_{rear} - L}{v_{rear} - v_{front}}$$



Tradeoffs

- **Speed:**
  - Fuel economy drops if you drive too fast (see right)
    - Also higher risk of a collision if you are much faster than surrounding vehicles
  - But if you drive faster at the beginning, you can get more miles in before the traffic hits
- **Gap:**
  - A larger gap is safer
  - But in congestion, a larger gap makes it more likely for other vehicles to cut in, slowing you down



Source: https://www.thesimpledollar.com/insurance/auto/fuel-efficient-driving-guide/

Scoring & Ranking

- 1st run: Practice
  2nd run: Ranked
- For fun, we will rank all schools based on how they did in the ranked run
- Rank is based on the following categories (equal weights given to each category):
  - Safety — How low was your accident risk, on average?
  - Mobility — How many miles did you travel?
  - Environment — How high was your average fuel economy?

Thanks for watching

- Have fun, and hope you learn something!
- See you at the event