

Check Your Gap or Get Scrapped

An Investigation of a Car Following Model

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Introduction

- Traffic flow theory deals with modeling vehicular flow.
- Focus on microscopic model which model cars as a single unit.
- Examine scenarios of homogeneous traffic, obstacles, and multi-lane bottleneck.

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Introducing variables

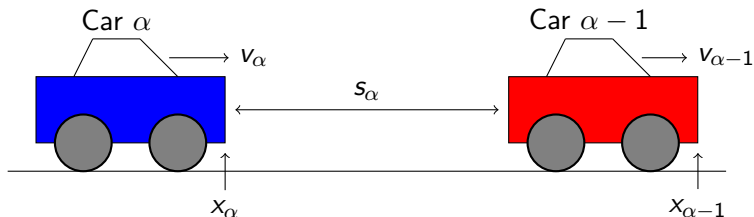


Figure 1: Defining index, position, velocity, and gap of a car.

- x_α , position of α th car.
- v_α , velocity of α th car.
- a_α , acceleration of α th car.
- s_α , gap of α th car.
- Will denote the car $\alpha - 1$ by car l .

Coupled Differential Equations

$$\begin{aligned}\frac{dx_\alpha(t)}{dt} &= v_\alpha(t), \\ \frac{dv_\alpha(t)}{dt} &= a_{\text{mic}}(s_\alpha, v_\alpha, v_l).\end{aligned}$$

Each car following model has a specific acceleration function:
 $a_{\text{mic}}(s_\alpha, v_\alpha, v_l)$.

Full Velocity Difference Model

$$a_{\text{mic}}(s_{\alpha}, v_{\alpha}, v_l) = \frac{v_{\text{opt}}(s) - v_{\alpha}}{\tau} - \gamma \Delta v,$$
$$v_{\text{opt}}(s) = \max \left(0, \min \left(v_0, \frac{s - s_0}{T} \right) \right).$$

-
- v_0 desired speed
 - s_0 minimum distance gap
 - T time gap
 - τ speed adaptation time
 - γ speed difference sensitivity

Graph of Optimal Velocity Function

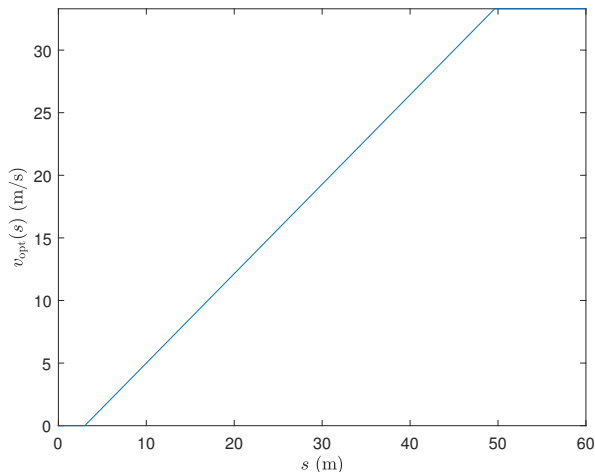


Figure 2: Graph of the optimal velocity function over a range of gaps.

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Forward Euler Method Scheme

$$v_{\alpha}(t + \Delta t) = v_{\alpha}(t) + a_{\text{mic}}(s_{\alpha}(t), v_{\alpha}(t), v_l(t))\Delta t$$

$$x_{\alpha}(t + \Delta t) = x_{\alpha}(t) + \frac{v_{\alpha}(t) + v_{\alpha}(t + \Delta t)}{2}\Delta t$$

Algorithm 1 Simplified algorithm for FDVM

Require: Initial state variables for each car at $t = 0$.

Require: carArr, an array of cars.

```
for  $i = 1 : \text{numsteps}$  do
  for  $j = \text{length}(\text{carArr}) - 1 : 1$  do
    State variables of  $j$ th car  $\leftarrow$  Update  $j$ th car by a timestep.
  end for
end for
```

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Homogeneous Traffic

Obstacle

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