Identifying Vehicle Behaviors in a Traffic Scene

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Goals

- Tracking vehicles has been done before…
Goals

- Now that we know exactly where you are, we would like to know exactly what you are doing:
  - Are you speeding?
  - Are you tailgating?
  - Are you cutting off other vehicles?
  - Do you weave through traffic?
  - Are you an aggressive driver?

- We can develop a computer program that can look at your vehicle’s position over time, and answer all of the above questions.
Phase 1: The Intelligent Driver Model

\[ \dot{v}_\alpha = a^{(\alpha)} \left[ 1 - \left( \frac{v_\alpha}{v_0^{(\alpha)}} \right)^\delta - \left( \frac{s^*(v_\alpha, \Delta v_\alpha)}{s_\alpha} \right)^2 \right] \]

- The equation above was developed for simulating traffic.
  - It controls how quickly cars move based on the speed limit and number of cars on the road
  - This can be useful for testing roadway designs without building the actual roads
- The model assumes that drivers only make safe decisions:
  - Car crashes will not occur in vehicles that fit the model
How We Can Use It

- If we know where the car is at every time, then we can also tell how fast it is going, and how much it is accelerating or braking:

\[
\dot{v}_\alpha = a^{(\alpha)} \left[ 1 - \left( \frac{v_\alpha}{v_{\theta}^{(\alpha)}} \right)^{\delta} - \left( \frac{s^*(v_\alpha, \Delta v_\alpha)}{s_\alpha} \right)^2 \right]
\]

- If we use this information in the equation, we can tell whether a car should be slowing down, or if it is safe for them to speed up.

- By comparing this to what the car actually does, we can easily identify vehicles that are showing unsafe behavior:
  - Speeding
  - Tailgating
Results: The IDM in Action
Phase 2: Learning Lanes

- The Intelligent Driver Model thinks there is only a single lane
  - This means that we cannot easily use it to find:
    - Drivers who weave through traffic
    - Drivers who cut off other drivers
- To accomplish these tasks, we have to find the lanes in the road.
Learning Lanes

- Remember, we want a computer to be able to do this knowing only where the cars are

- We can use a type of artificial intelligence known as Machine Learning
  - This is just a way to teach a computer how to identify something
Lets Take a Look at Our Data
Zoom in a Little…
What if we take just a small chunk?
We can find the centers using Expectation Maximization.
And repeat this several times
And repeat this several times
And repeat this several times
Until we have done this for the whole length of road
Then we can connect the dots
For each lane
For each lane
Learning Lanes

- Now that we have identified the centers of the lanes, we can easily:
  - Tell which car a lane is in based on its position

- Expectation Maximization also tells us how much the cars tend to move away from the centers of lanes
  - We can judge how likely it is that a car is changing lanes
  - We can also identify cars that swerve around in lanes (drunk/careless drivers)
Once we have lanes…

- We will be able to accurately detect many other behaviors
  - Rapid lane changing
  - Cutting people off
  - Weaving through traffic
  - And more…

- There are many other behaviors we can explore using vehicle tracking…