Motion Prediction

Course 4, Module 4, Lesson 1

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FACULTY OF APPLIED SCIENCE & ENGINEERING

Learning Objectives

- Define the motion prediction problem for dynamic objects and its importance to planning
- Identify the requirements for accurate motion prediction
- Perform predictions with the Constant Velocity Prediction Model

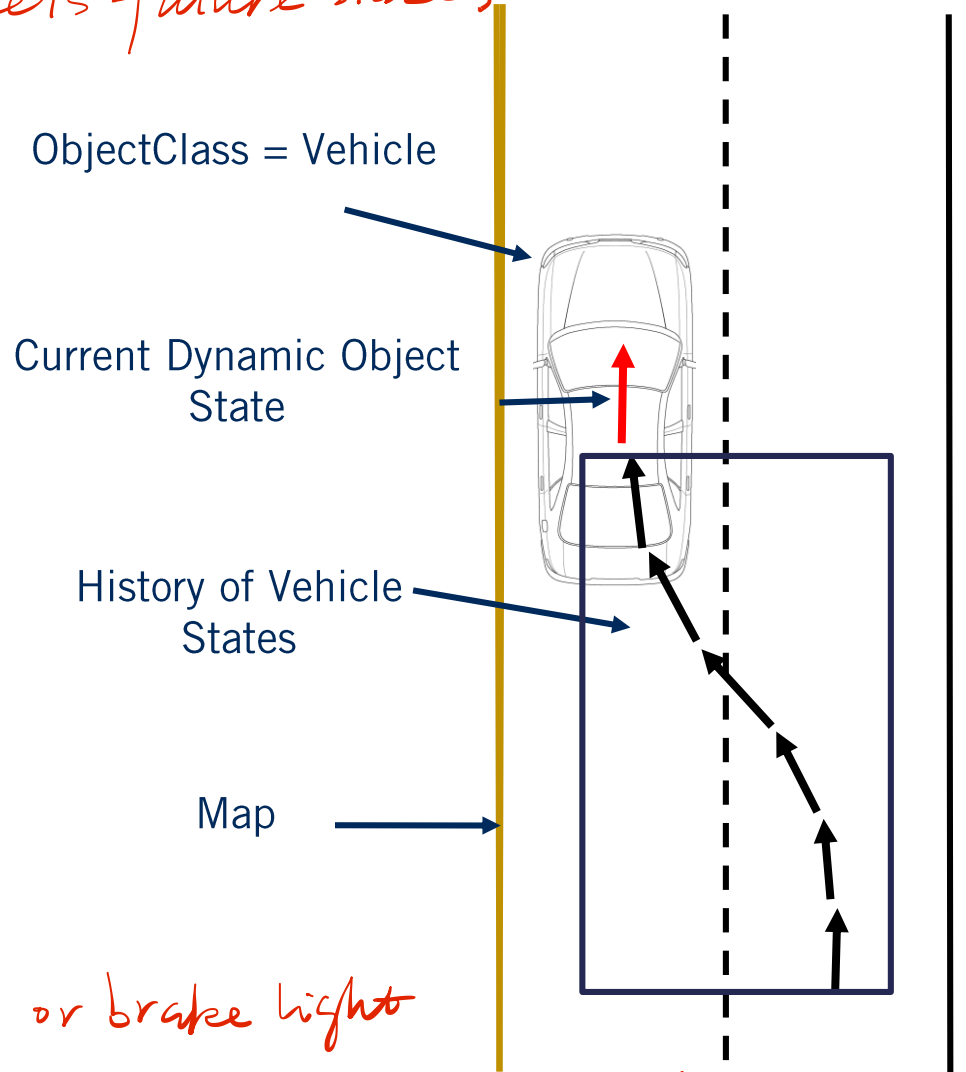
Motion Prediction - Definition

- Motion prediction of the dynamic object's attempts to estimate the future position, heading and velocity
- Important as it allows:
  - Planning a set of maneuvers to correctly interact with dynamic objects
  - Avoid collisions on a planned trajectory

Requirements for Motion Prediction Models

dynamic objects future states

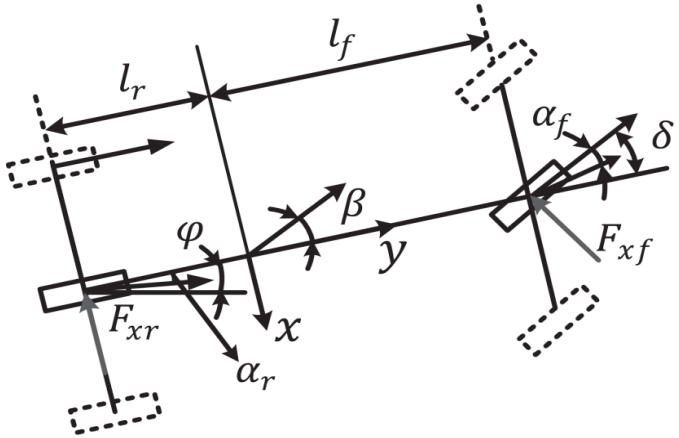
- Mandatory Requirements:
  - Class of Dynamic Object
  - Current position, heading and velocity
- Optional Requirements:
  - History of the position, heading and velocity
    - Requires object tracking between identifications over a set amount of time
  - Current high definition roadmap
  - Image of the current dynamic object



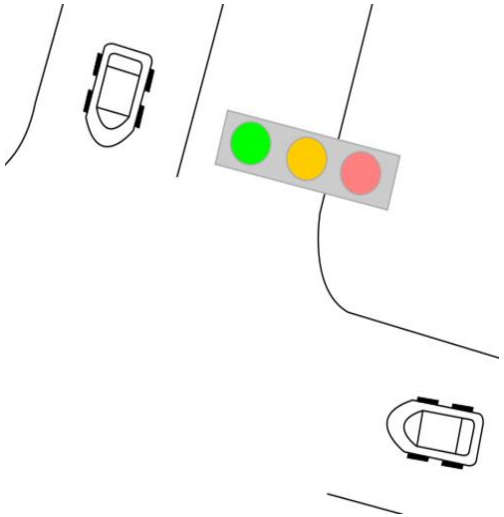
current indicator light or brake light

current orientation of person (even though stationary now)

Simplification of Motion Prediction - Cars

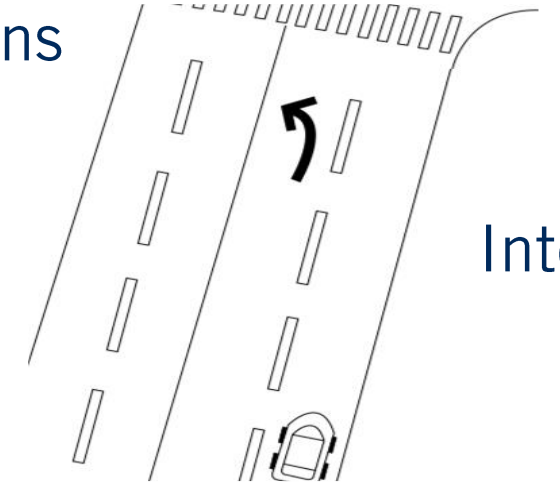


Physics-based Assumptions



Interactions-aware Assumptions

Vehicles react & interact with each other



Maneuver-based Assumptions

Complexities of Motion Prediction - Pedestrians

restricted motion due to low top speed

Pedestrians are unpredictable!

Can rapidly change speed and heading

Pedestrians use crossings
Pedestrians use sidewalks

Pedestrians have right of way, but will stop if threatened

Constant Velocity Prediction Model

- Simple
- Computationally efficient
- Assumption is that the dynamic object will maintain its velocity
  - Magnitude
  - Heading

Constant Velocity Prediction Model - Algorithm

- Input:
  - T – time horizon to predict over
  - dt – time between predictions
  - x_{obj} – current dynamic object state
    - Position: x_{obj}.pos
    - Velocity : x_{obj}.vel
- Output:
  - $x_{1:T}$ – list of future vehicle states

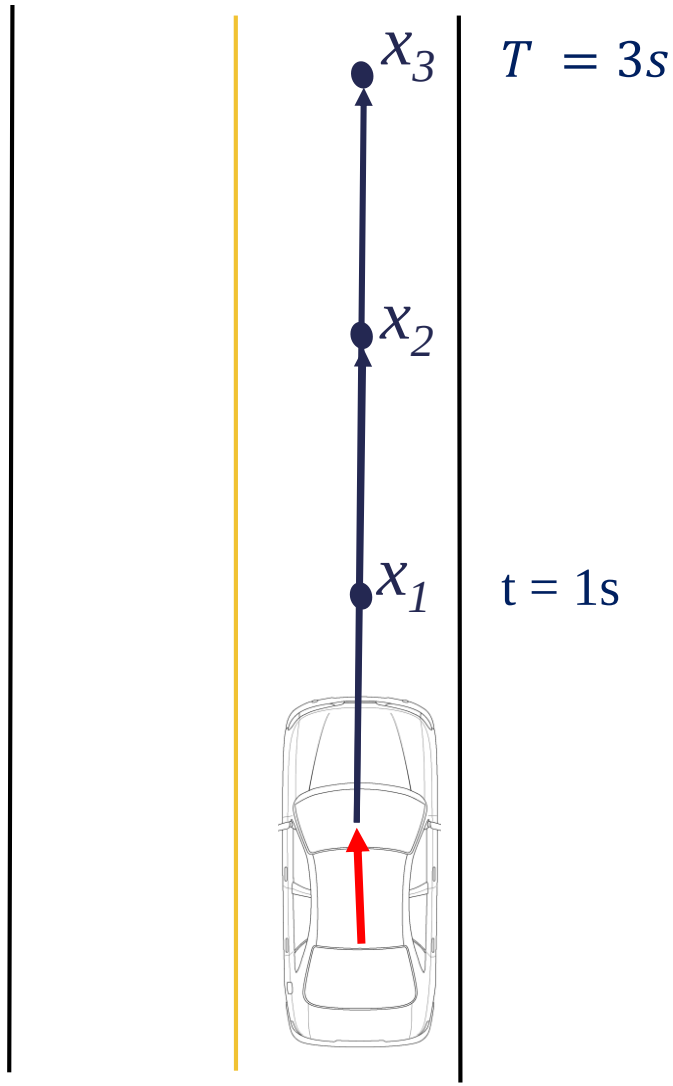
Algorithm Constant Velocity Prediction(x_{obj})

1. $t \leftarrow 0$
2. $x_0 = x_{obj}$
3. **while** $t * dt < T$ **do**
4. $\quad t = t + 1$
5. $\quad x_t.\text{pos} \leftarrow x_{t-1}.\text{pos} + dt * x_{t-1}.\text{vel}$
6. $\quad x_t.vel \leftarrow x_{t-1}.\text{vel}$
7. **end while**
8. **return** $x_{1:T}$

Constant Velocity Prediction Model - Example

- Input:
  - $T = 3$ seconds
  - $dt = 1$ second
  - x_{obj}
- Output:
  - $Predictions$

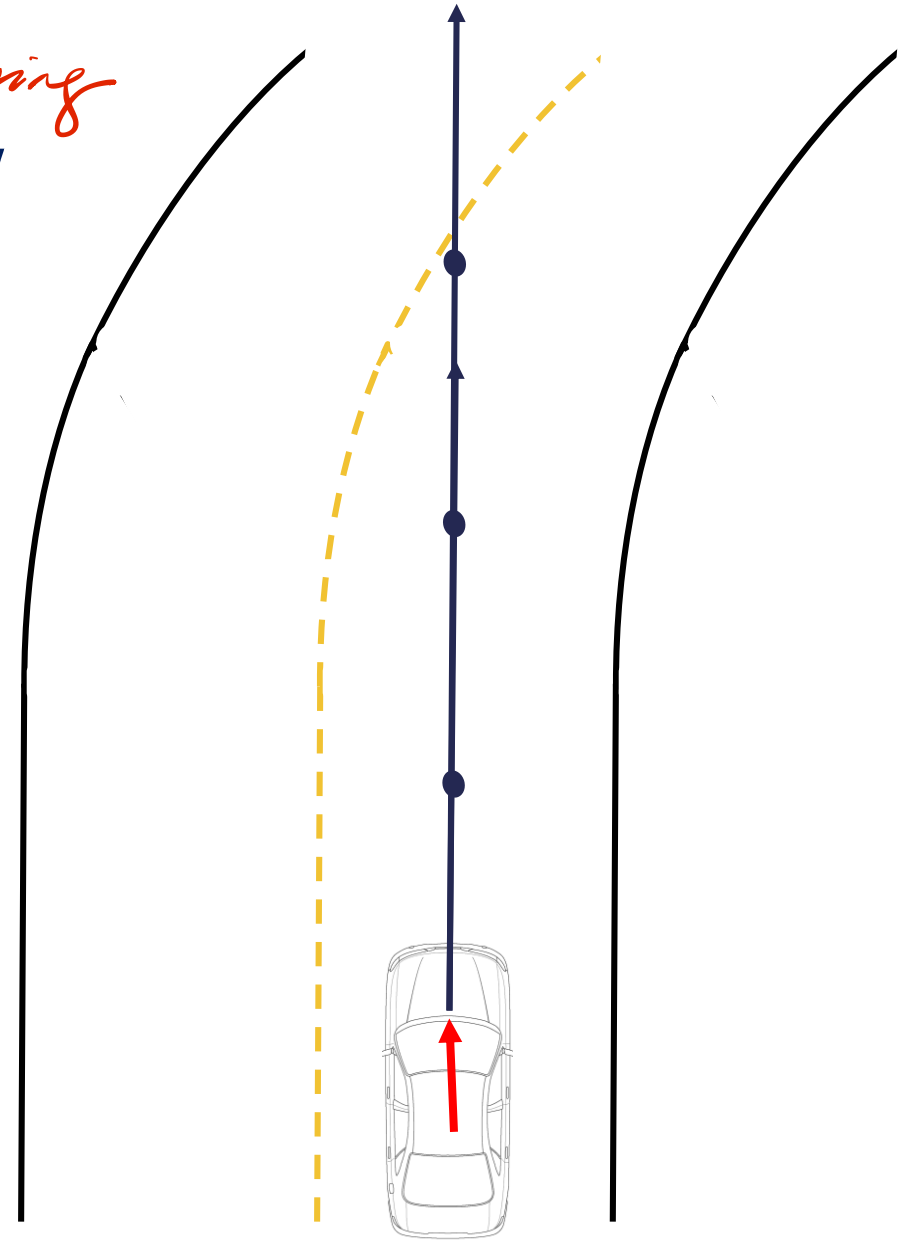
x_1 x_2 x_3



Constant Velocity Prediction Model - Issues

acceleration/ deceleration/ steering

- Don't account for Vehicle Dynamics fully
- Don't account for the Road (Position adjustment)
- Don't account for Road Signs (Velocity adjustment)
- Assumptions are too Strong and Incorrect for most Dynamic Object Motion



Summary

- Identified motion prediction and its Importance
- Requirements for motion prediction
- Assumption for Simplifying the problem in the case of
  - Vehicles
  - Pedestrians
- Simple Constant Velocity Prediction Model
- Issues with Simple Constant Velocity Prediction Model

- **Next**: Map-aware Motion Prediction Model