

Motion Prediction

Course 4, Module 4, Lesson 1

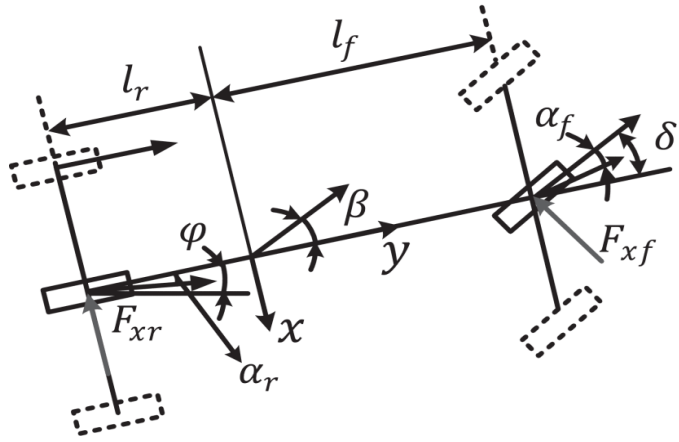


UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING

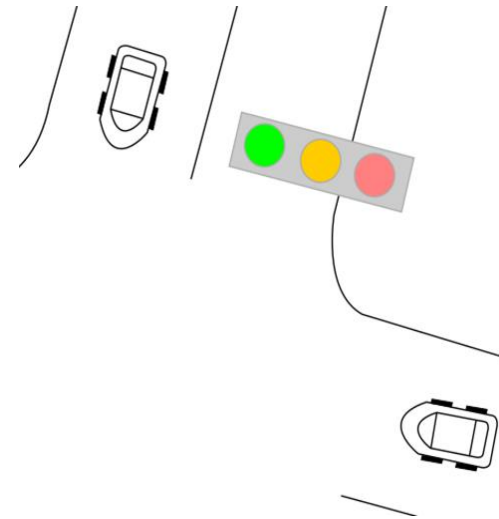
Motion Prediction - Definition

- 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

Simplification of Motion Prediction - Cars

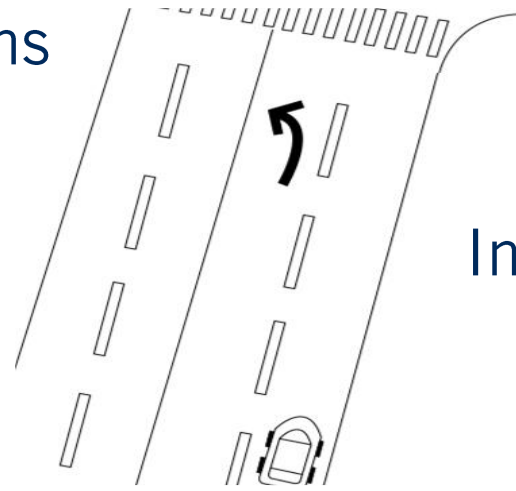


Physics-based Assumptions



Interactions-aware Assumptions

Vehicles react & interact with each other



Maneuver-based Assumptions

Complexities of Motion Prediction - Pedestrians

Pedestrians are unpredictable!



Can rapidly change speed and heading



Pedestrians use crossings
Pedestrians use sidewalks

*restricted motion
due to low top speed*



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

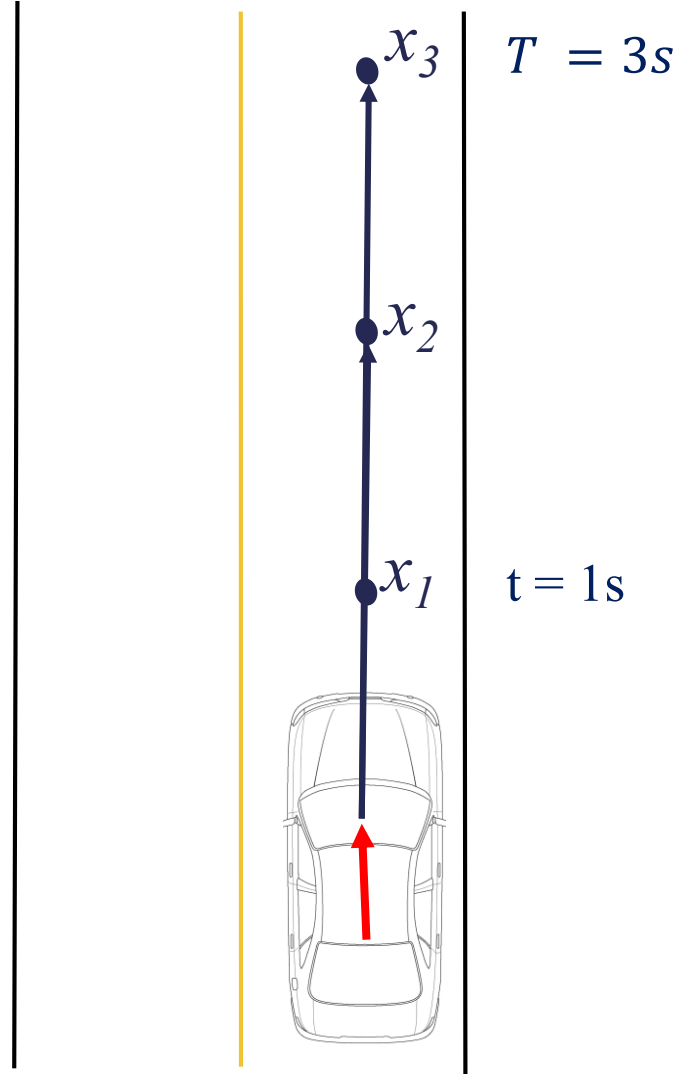
Algorithm Constant Velocity Prediction(x_{obj})

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

Constant Velocity Prediction Model - Example

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

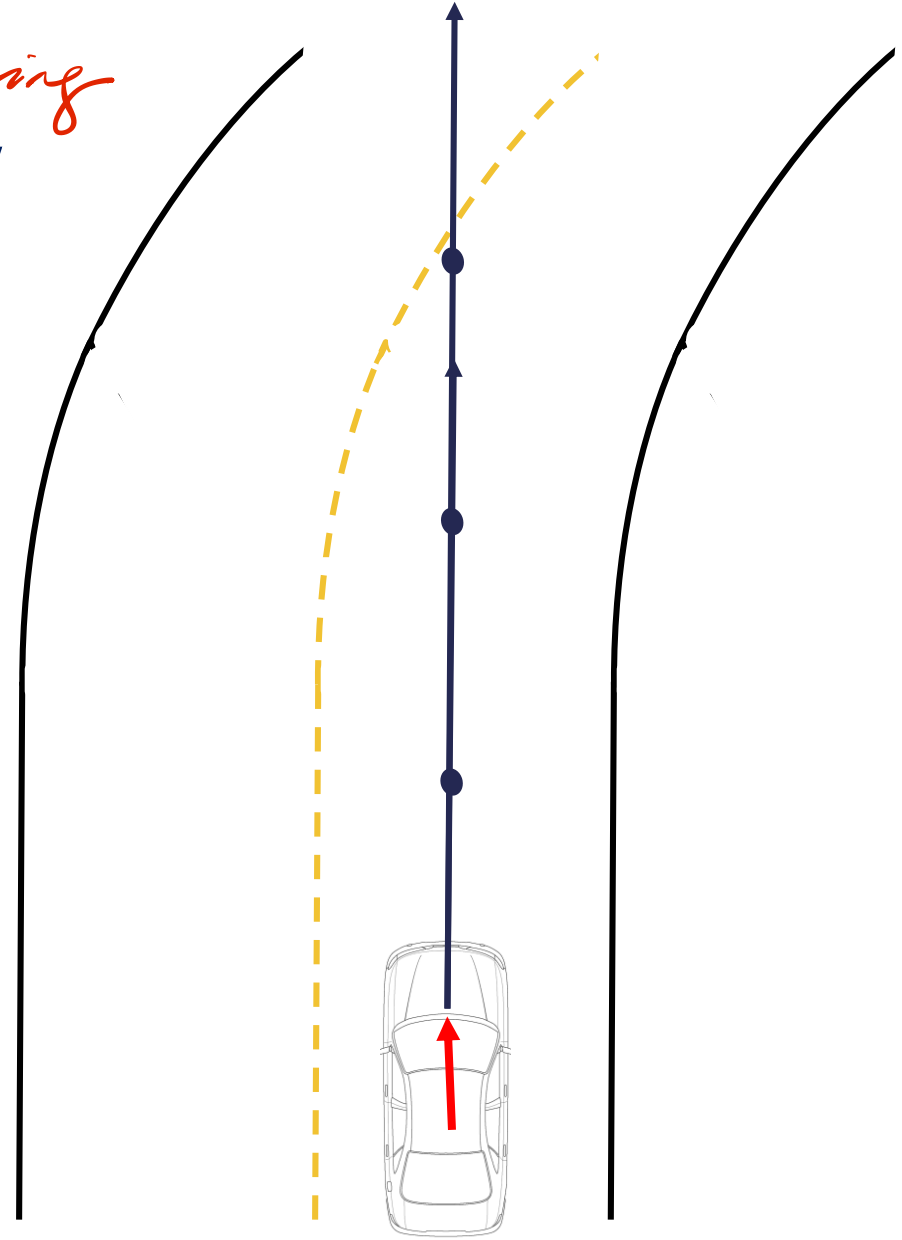
x_1 x_2 x_3



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