

Objective Functions for Autonomous Driving

Course 4, Module 1, Lesson 3



UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING

Learning Objectives

- List some useful objective functions for performing motion planning
- Understand the benefits and the behaviours that each objective function tries to encourage

Efficiency

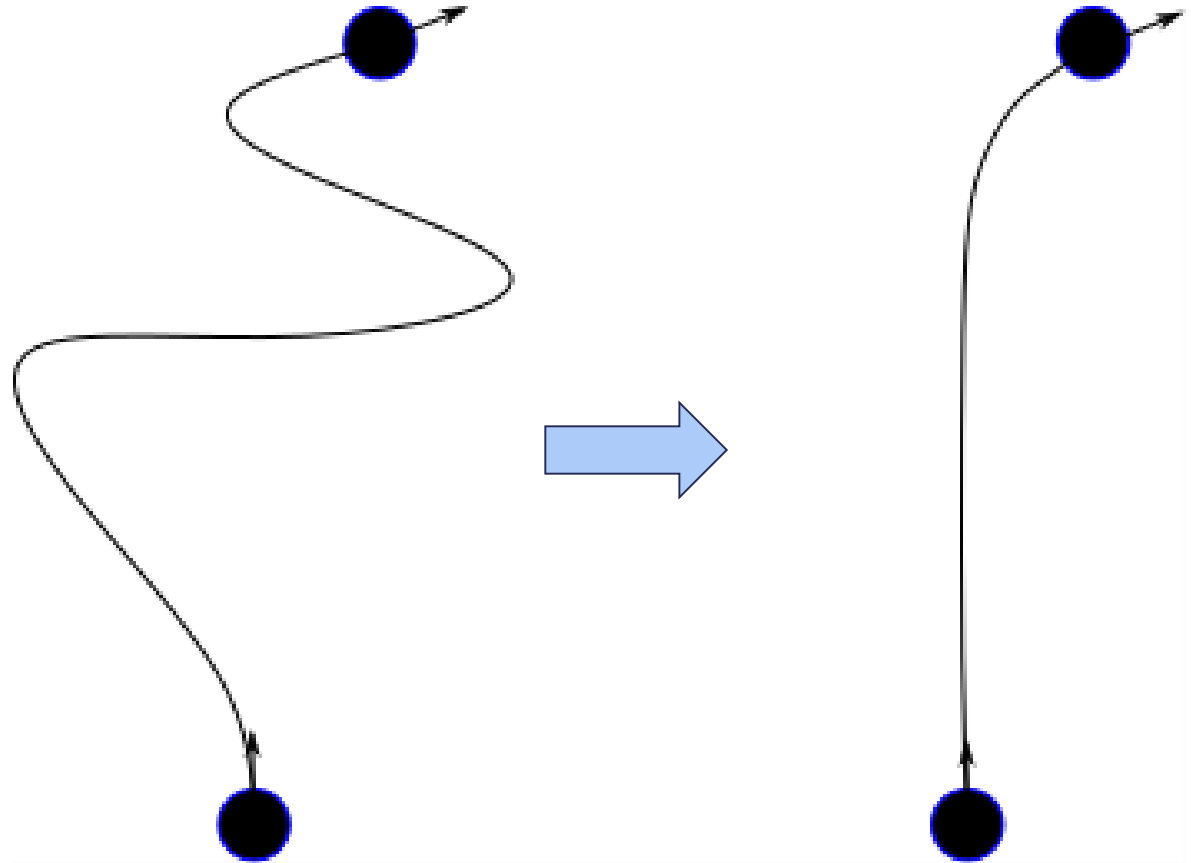
- Path length:
 - Minimize the arc length of a path to generate the shortest path to the goal
- Travel time:
 - Minimize time to destination while following the planned path

$$S_f = \int_{x_i}^{x_f} \sqrt{1 + \left(\frac{dy}{dx}\right)^2} dx$$

$$T_f = \int_0^{s_f} \frac{1}{v(s)} ds$$

Efficiency – Path Length Example

$$S_f = \int_{x_i}^{x_f} \sqrt{1 + \left(\frac{dy}{dx}\right)^2} dx$$



Reference Tracking

- Penalize deviation from the reference path or speed profile

$$\int_0^{s_f} \|x(s) - x_{ref}(s)\| ds$$

$$\int_0^{s_f} \|v(s) - v_{ref}(s)\| ds$$

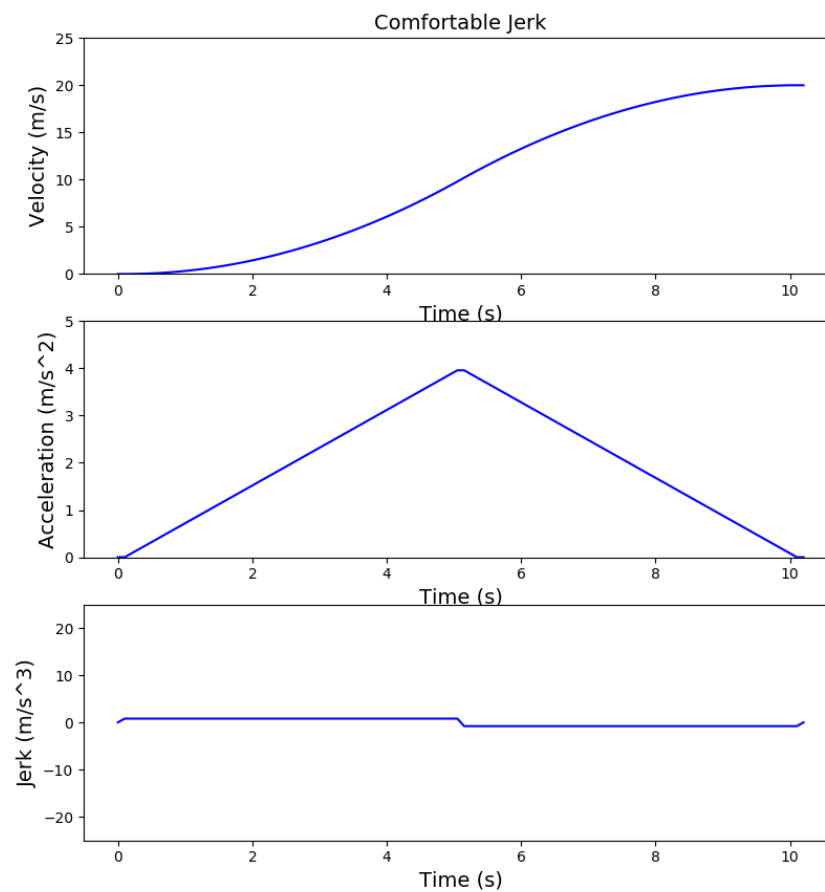
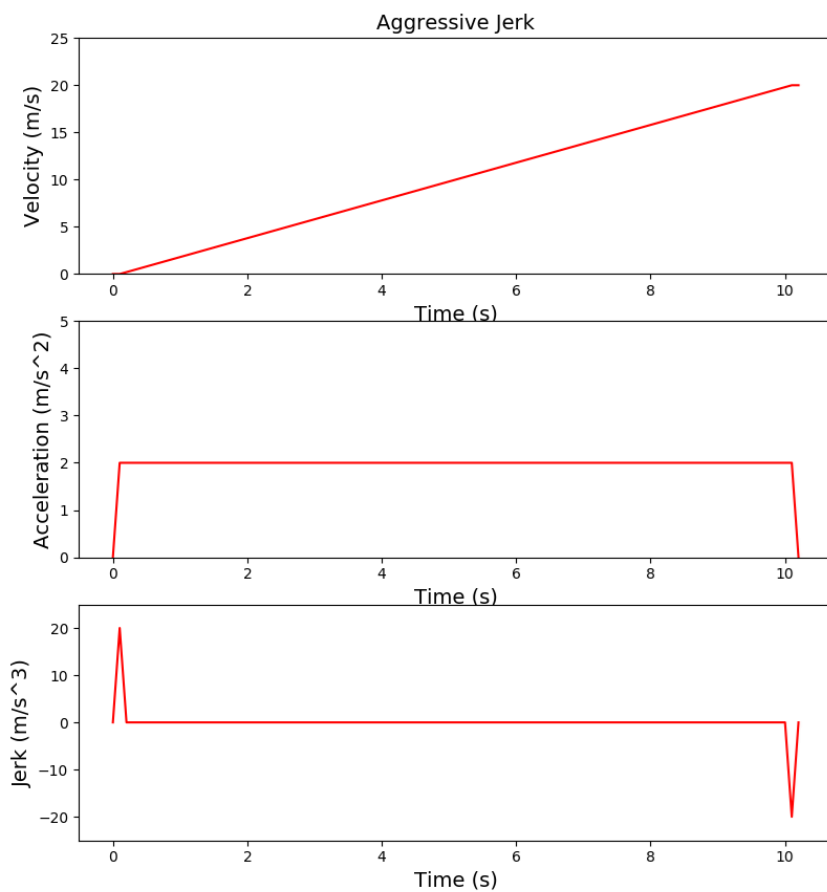
- For velocity:
 - Hinge loss to penalize speed limit violations severely

$$\int_0^{s_f} \left(v(s) - v_{ref}(s) \right)_+ ds$$

Smoothness

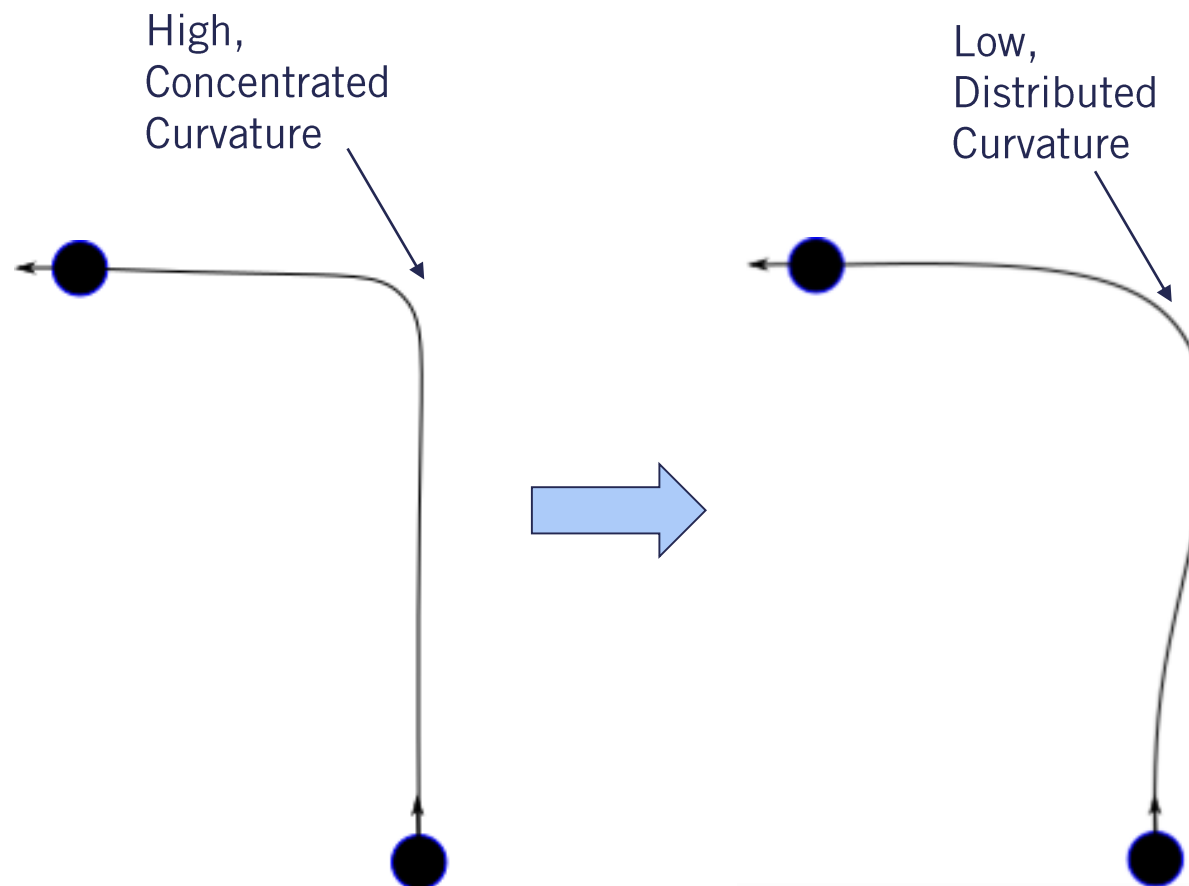
$$\int_0^{s_f} \|\ddot{x}(s)\|^2 ds$$

Jerk



Curvature

$$\int_0^{s_f} \|\kappa(s)\|^2 ds$$



Summary

- Explored objective functions related to efficiency, comfort, and reference tracking
- Discussed how each of these objectives changes the optimal path
- Described the benefits the objectives impart to the planned path



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